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RAFFERTY-ALAMEDA PROJECT

ENVIRONMENTAL IMPACT STATEMENT

**Souris Basin
Development
Authority**

CHAPTER 3

BENEFIT COST ANALYSIS

RAFFERTY/ALAMEDA ENVIRONMENTAL IMPACT STATEMENT

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1.0 INTRODUCTION

1.1 Scope of Study

This report has been conducted under the direction of the Souris Basin Development Authority. One component of the Development Authority's mandate is to review and analyze the implications of various development options for the basin in Saskatchewan and to coordinate the development of such identified basin projects. Two dams (Rafferty and Alameda) have been identified as providing methods for effectively managing the basin's water resources. The Authority is preparing an Environmental Impact Statement of the proposed dams as an assessment of the implications of the proposed project on the basin's natural and socio/economic environment. This report is intended as background information to be incorporated by the Authority into the more comprehensive Environmental Impact Statement.

1.2 Objectives of the Study

The objectives of this study are to evaluate the economic impacts and develop both direct and societal (secondary) benefit/cost ratios for the proposed dams, considering the total cost and the potential beneficiaries of the dams and appurtenances. The analysis is to be extended beyond quantitative benefits and costs to include all those factors which impact on the region and the province, but are difficult to quantify and are not components of the traditional benefit/cost formulations. Potential downstream beneficiaries include the United States of America. Negotiations between Saskatchewan and the USA governments have been quite extensive and have resulted in agreement on an Operating Plan for all major control structures in the Souris River in both Saskatchewan and North Dakota. For the purpose of analysis here, it will be assumed that American benefits are equal to their negotiated contribution.

Impoundments on the Souris River have been considered as potential water management tools for at least the past 50 years. A vast array of background information has been developed over the years as studies were commissioned to evaluate the various aspects of engineering, hydrological, environmental, recreational, sociological and economic impacts of constructing dams in the basin. This study will not regenerate data already developed within these previous studies, but rather it brings the various analyses together, filling some minor data voids and evaluates the socioeconomic impacts within one comprehensive study. Consequently, this study relies heavily on materials from previous reports.

1.3 Report Format

The introduction is followed by sections covering the following:

- Summary of previous reports and major data sources used as background data for this study.
- An analysis of the concept of water scarcity and its measures for various Saskatchewan river basins.
- Discussion of the quality of life and the various non-quantified components of the analysis and their impacts on the proposed project.
- List the major beneficiaries and contributors to the project, followed by a comprehensive economic analysis of the total project.
- Summary and conclusions.

The appendices will provide more detail on the beneficiaries and contributors and on the economic methodologies employed.

2.0 PREVIOUS WORK AND MAJOR DATA SOURCES

"Rafferty and Alameda Reservoirs Conceptual Evaluation of Irrigation and Recreation Costs and Benefits," Volumes 1 and 2. Saskatchewan Water Corporation and Water Resource Consultants, 1985.

> This report is a comprehensive analysis of the benefits and costs related to irrigation development. Irrigation benefits and costs for the current study are taken directly from the WRC report. Recreation benefits and costs described in the above report are not totally inclusive and serve only as background material for the current study.

"Souris River Basin Study;" Prairie Farm Rehabilitation Administration, Souris River Basin Study Board.

> This study provided the basis for flood control work in the basin. The Basin Study included an assessment of urban flood damages based on a joint Canada-Ontario study carried out by Acres Limited in 1968. This landmark study established depth/damage curves for a range of residential and commercial buildings and contents and created a methodology for estimating direct damage costs. The results of Acres studies were used as a base and estimated damages in the study area were updated to 1986 dollar values.

"Saskatchewan Power Corporation /Fennell Cochrane Lavalin/ Souris Basin Development Authority (SBDA)"

> The above organizations are currently involved in predesign work for dam construction. In general, dam construction costs, valley preparation costs, power and transmission costs, transportation mitigation costs and oil well mitigation costs were supplied from the above through SBDA.

"Saskatchewan Recreation Survey," Saskatchewan Water Corporation and University of Saskatchewan

Park utilization rates and personal recreation spending estimates from the above study were supplied by the University of Saskatchewan.

"Background Studies," Souris Basin Development Authority

Primary data relating to agriculture, population parameters, and recreational capacities were taken from the above reports.

3.0 SOURIS BASIN AND THE PROPOSED PROJECT
A DESCRIPTION

3.1 The Souris Basin

The Souris River is a prairie river originating on the plains south of Regina. The river flows in a southeasterly direction and crosses the Saskatchewan/North Dakota border south of Oxbow, Saskatchewan. The river flows as far south as Minot, North Dakota, and returns north to join the Assiniboine River southeast of Brandon, Manitoba.

The Saskatchewan portion of the Souris basin is comprised of the Souris River and three main tributaries: Moose Mountain Creek, Long Creek and Roughbark Creek. The basin area is 29,600 km^2, including those most easterly Saskatchewan portions of the watershed which drain directly into the Souris River in Manitoba.

The Boundary Dam and Reservoir have been developed on Long Creek. The reservoir supplies cooling water to the Boundary Dam Power Station and also municipal water to the City of Estevan. These two demands are currently utilizing virtually all of the total storage capacity. In addition to the above two uses, the reservoir provides some downstream flood control and creates a very limited environment for cottage development.

The Souris basin area is semi-arid with an annual frost free period of 90 to 110 days, and a growing season of 175 days. Total precipitation varies from 380 mm in the southern Saskatchewan portion of the basin to 455 mm on the higher elevations in the Moose Mountain Creek area. The average crop water deficit for the area is 260 mm.

The Souris River basin is predominantly a farming and mining area. Farms in the area are slightly larger than the provincial average and tend towards a mixed product base as a result of scarce water.

3.2 The Proposed Project

Peak electric energy demands in Saskatchewan are nearing maximum capacities. In anticipation of continued demands, the Saskatchewan Power Corporation is initiating the construction of the Shand thermal generating plant to be located near Estevan. The plant will eventually consist of two 300 mW power units. It is currently anticipated that one power unit will be air cooled and the other water cooled. The provincial thermal plants to date have been water cooled, as there is limited local expertise for air-cooled technology. Water supplies in the Estevan area are limited and, without further water development in the area, sufficient water would not be available for the proposed watercooled power unit; thus both power units would have to utilize the less fuel efficient air cooled thermal process technology.

It has been proposed that two complementary dams be constructed in the Souris basin to supply the additional water required for the Shand thermal plant, in addition to other potential uses for agriculture, recreation, municipalities and flood control. The larger dam and reservoir (Rafferty) will be developed just upstream of Estevan. This dam will capture flows from both the Souris and Roughbark Creeks. The smaller dam and reservoir (Alameda) is to be constructed on Moose Mountain Creek upstream from Oxbow. The dams' functions are complementary to each other, and are thus simultaneously considered in this analysis as one project. Current and potential demand for surface water in the basin includes cooling for thermal power generation, flood control, irrigation, municipal water supply, and recreation. In addition, international flow commitments require water to be passed on to the USA.

The proposed Rafferty reservoir (4,545 hectares) will be the third largest artificial impoundment in Saskatchewan. The reservoir will be an earth zoned dam with a concrete spillway and an energency earth spillway to the side. At full supply levels (550.5 m), the reservoir will have a maximum depth of 14.0 m immediately above the dam and a volume of 392,000 dam^3 (318,000 acre feet).

The proposed Alameda reservoir (1,130 hectares) will have a maximum depth of 24 m and a volume of 96,600 dam^3 (78,400 acre feet). The Alameda dam will also be an earthfill dam with a concrete spillway.

The following water management scenario is the basis for the Rafferty and Alameda Dams benefit/cost analysis within this study.

The Rafferty Dam on the Souris River will provide cooling water for one 300 mW thermal power unit at the Shand plant; flood control from 25 km downstream of Weyburn into the U.S.A.; irrigation and municipal water supplies; and water-based recreation on and adjacent to the reservoir. There will a water diversion channel between Boundary Dam and the Rafferty Reservoir. The dam will be built at a location referred to as Site "C" with a full supply level of 550.5 m and a flood surcharge level of 554.0 m.

The Alameda Dam on Moose Mountain Creek will provide flood control storage, irrigation water supply, water based recreation on and adjacent to the reservoir, and international flow commitments. The multipurpose full supply level of the reservoir will be 574.0 m and the flood surcharge level will be 579.0 m.

4.0 SCARCITY OF WATER

Water is vital to life, but abundant supplies throughout much of Canada have created an attitude of neglect towards water resources in this century. Unfortunately, not all regions have abundant water resources. In these areas, water becomes a valuable resource with more public pressure to intensively manage it. Whereas water development projects with marginal returns are usually considered not feasible in a region of abundant water supplies, much more caution must be used in the evaluation of a project in areas of scarce water supplies.

The Souris basin is an area of limited water supply. Surface water is only available in the project area through the Souris River and its tributaries. Except for a few weeks of spring runoff, stream flows are minimal; therefore opportunities for water use are limited. Because of the relative scarcity of water within the basin, a significant effort has previously been expended in evaluating the opportunities of managing the available water supplies, and, in particular, heavy spring flows.

The purpose of this section is to demonstrate the relative scarcity of water in the Souris Basin compared to other river basins within Saskatchewan. This will be accomplished by demonstrating actual quantities of water, and by discussing water-based activities in these basins and other measures of economic development.

Saskatchewan basins chosen for comparison are the Souris, Qu'Appelle, South Saskatchewan, North Saskatchewan, Northern (Churchill, Athabasca, Tazin, Kasba), and Assiniboine. The Missouri River basin was not included as available data was not complete.

The measures chosen as a base for water scarcity measurements are crop water deficits, basin water yields per square kilometer, annual variability in water yields, average minimum flows during the year, water surface area per square kilometer, number of water-based recreation sites per unit of population, population density, and basin population changes relative to Saskatchewan population changes.

Scarcity index values are shown in Table 1. Index values for the Souris basin, in general, definitely indicate a relative lack of water within the Souris Basin. A discussion of individual index measures follows.

Basin water yield (dam^3) per basin area (000 km^2) is an indication of the amount of surface water flowing from a basin. It is intended as a measure of the water available within the basin, before an allowance has been made for apportionment (agreements) to supply domestic industrial and agricultural users. The Souris basin scores the second highest scarcity index with a yield of 4.29 dam^3 per 1000 km^2, compared to 4.07 dam^3 for the North Saskatchewan River basin.

The coefficient of annual streamflow variability is the standard deviation of monthly discharge means divided by the average of monthly discharge means. Although total water yield may be high if the bulk of the flows occur in a relatively short period of time without proper water management facilities, the basin will still have scarce water supplies. The Souris basin is clearly the leader in variabilities of yield, followed by the Assiniboine basin. Note that the variability for the Souris U.S.A. basin is smaller than in Saskatchewan. This can be attributed to the extensive in stream development in the U.S.A. Relatively high numbers can be expected in these two rivers, which originate on the prairies, without a perennial ice pack to act as stabilizing headwaters throughout the year.

Average minimum flow is the average daily discharge during the lowest seasonal flows for each year of record. Minimum flows are indicative of fishery opportunities within the stream and irrigation and recreational potential. Both the Souris and the Assiniboine rivers have recorded no flows and both rivers experience extremely low flows during the summer when demand is the highest, which indicate dramatically water scarce regions.

Water surface area per total basin area (km^2/km^2) is a measure intended to indicate the availability of water-based recreation opportunities within the basins. The results indicate a significant lack of water surface available for recreation. The Souris basin again has the smallest water surface area. The next smallest surface area within Saskatchewan, relative to basin area, is the Assiniboine with seven and one half times as much water area as the Souris basin. This indicates a major lack of opportunities for recreational activities such as fishing, boating and cottaging within the basin. The Souris U.S.A. basin has about as much water surface area as the Assiniboine basin. It is interesting to note that over sixty percent of the water surface area in the Souris U.S.A. is from man-made empoundments.

The rural population decline in Saskatchewan has been more pronounced in some areas. (See Socioeconomic Section of the E.I.S.). Opportunities to earn an adequate living and existing social amenities will play an important role in determining which areas are most prone to population declines. The measure of population decline used herein is in proportion to total Saskatchewan rural declines; for example, an index of 112 is interpreted as twelve out of 100 more people left the Souris basin than left other rural areas of Saskatchewan. The South Saskatchewan basin had the largest rural decline of 14% over the provincial trend. Water resources represent a significant component of quality of life amenities and, to some degree, industrial opportunities. The relatively large decline in the rural basin population may in part be a result of the high water scarcity index for the Souris basin.

Population densities per km² indicate sparse populations in the Northern river basins and for the Saskatchewan river basins. Population densities in the Souris basin appear to be about average, which is indicative of the absence of the influence of major urban centers.

The number of water based park sites per population (000) is indicative of the degree of recreational development that has occurred within the basin. The Souris basin ranks third in park site scarcity within Saskatchewan and is one half of the park site development of the Souris U.S.A. The large range in numbers of developed sites indicates recreationists' mobility to travel to other river basins. The density of recreationists at campsites may be more indicative of demands for recreation within each river basin.

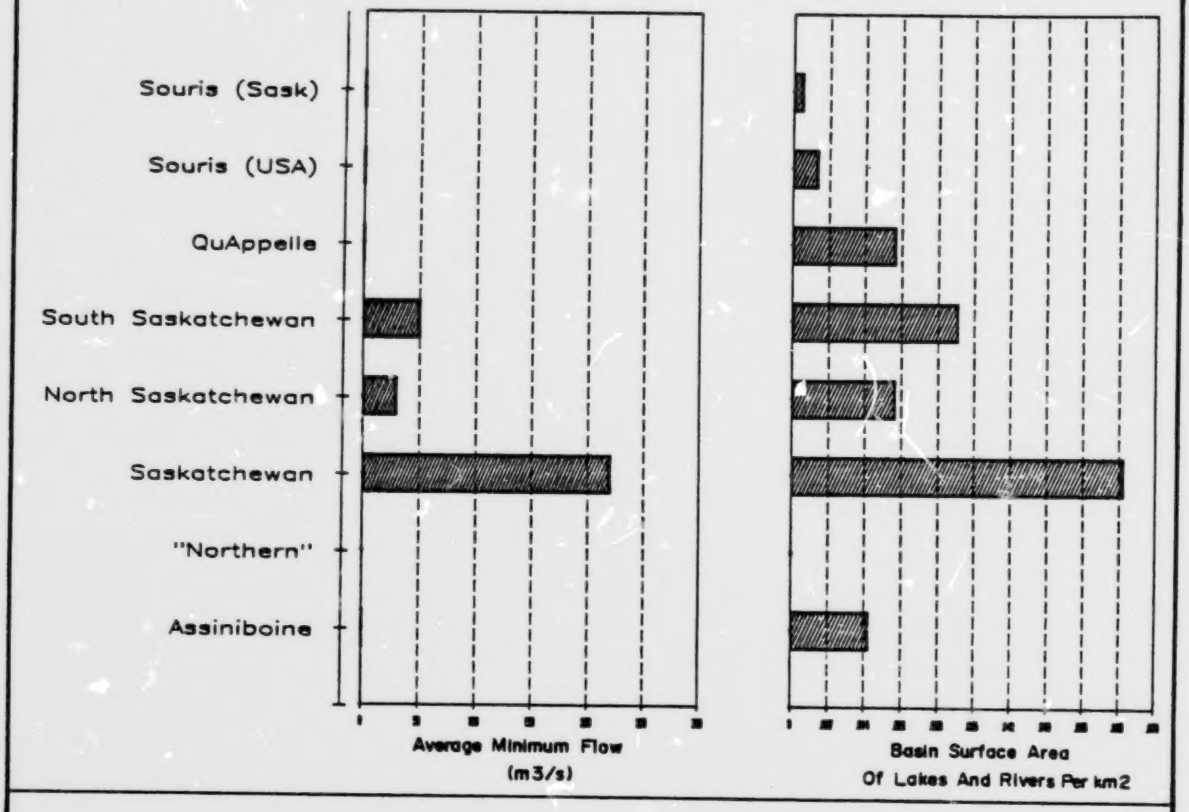
Crop water deficit is a measure of the difference between soil moisture estimated to be available to a crop during the year and the amount of water the crop could utilize (potential evapotranspiration). Those areas with higher deficits can be expected to place a high value on available water supplies. The water deficits indicated in Table 1 are general and represent the climatic conditions where most of the basin lies. The South Saskatchewan and the Souris U.S.A. basin have the highest crop water deficit at 300 mm, while the Souris has the next largest at 225 mm, which is significantly above the 182 mm average of all the river basins analyzed.

TABLE 1: SCARCITY INDEX COMPONENTS BY RIVER BASIN *

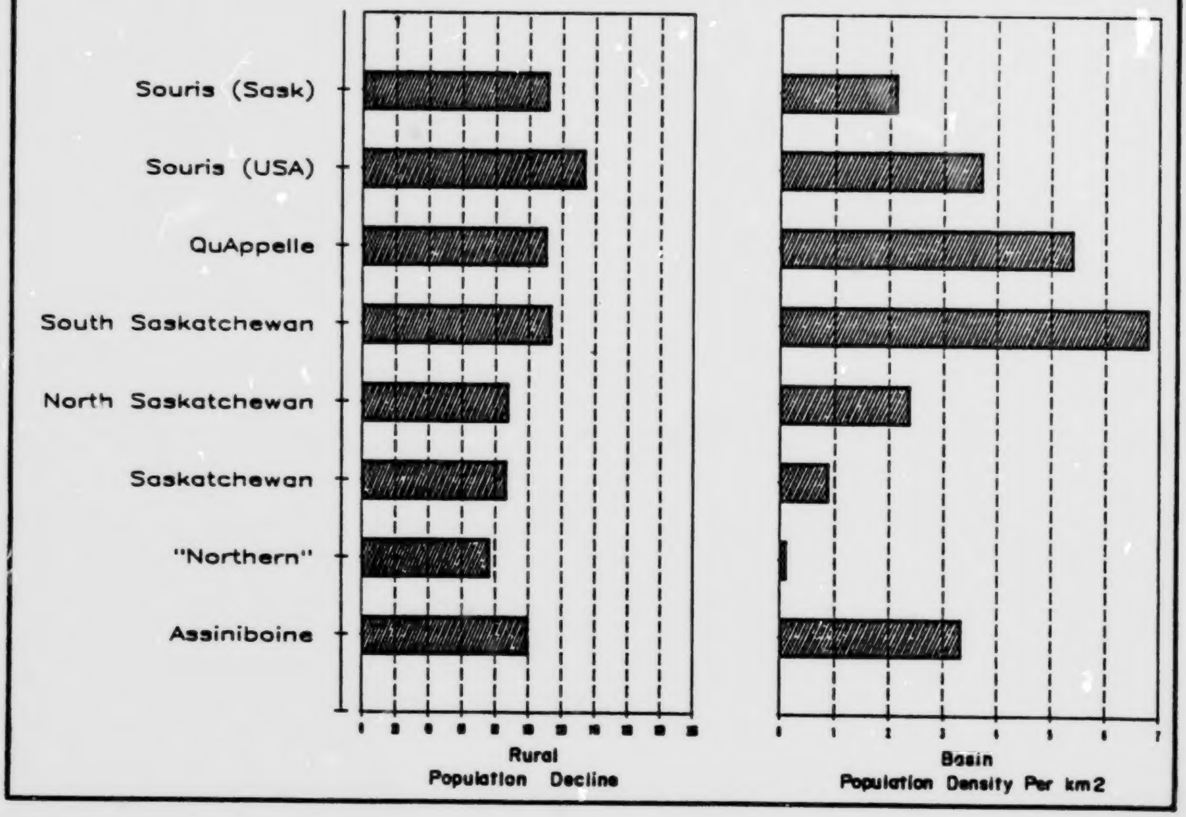
	WATER YIELD/ BASIN AREA (dam3/km2)	ANNUAL STREAMFLOW VARIABILITY **	AVERAGE MINIMUM FLOW (m3/s)	BASIN SURFACE AREA OF LAKES AND RIVERS PER KM2	RURAL POPULATION DECLINE	BASIN POPULATION DENSITY PER KM2	WATER BASED PARK SITES PER CAPITA	CROP WATER DEFICIT/ YEAR(mm)
SOURIS (Sask)	4.29	1.65	0.07	0.002	112	2.14	0.28	225
SOURIS (USA)	5.25	1.32	0.40	0.005	134	3.73	0.59	300
QuAPPELLE	5.21	0.84	1.3	0.02	111	5.41	0.17	175
SOUTH SASKATCHEWAN	20.50	0.31	51	0.032	114	6.81	0.14	300
NORTH SASKATCHEWAN	4.07	0.76	30.5	0.02	88	2.38	0.36	200
SASKATCHEWAN	66.99	0.34	221	0.064	87	0.89	1.52	125
"NORTHERN"	69.15	n/a	n/a	n/a	77	0.12	1.73	75
ASSINIBOINE	9.54	1.51	0.05	0.015	100	3.34	0.33	175

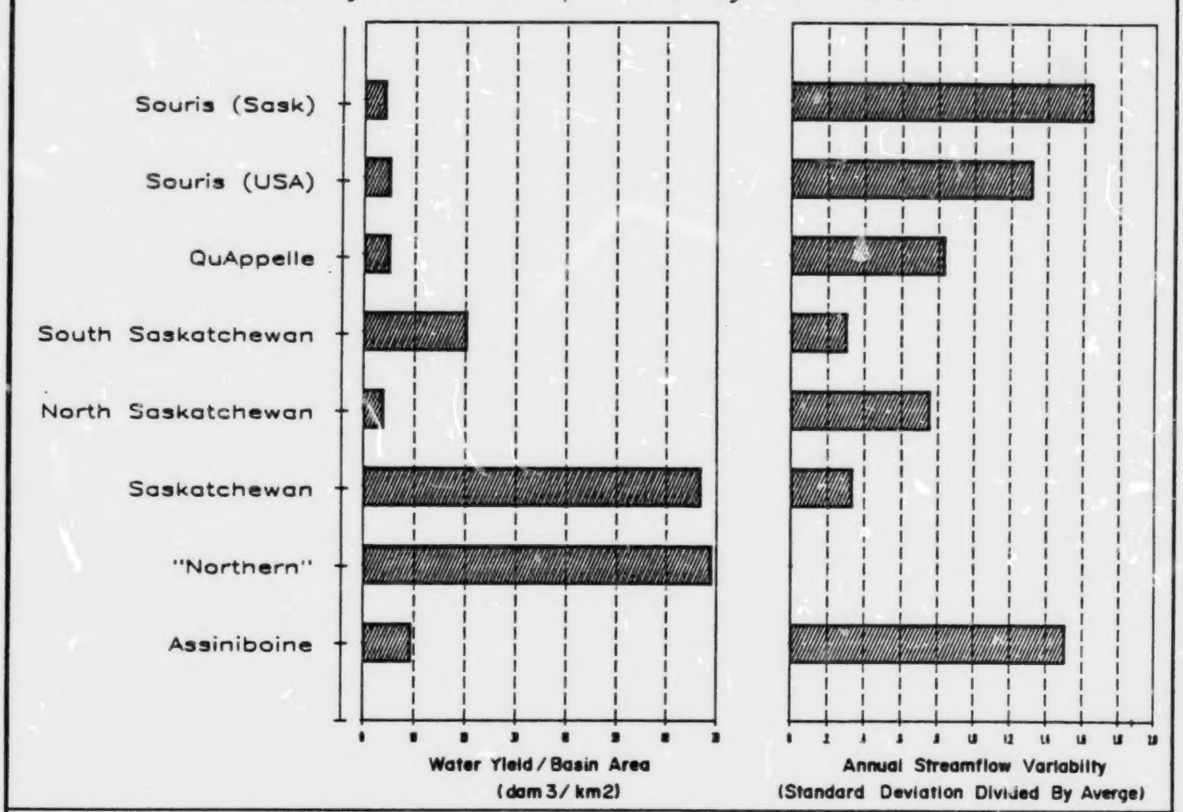
* - n/a - NOT AVAILABLE
** - STANDARD DEVIATION DIVIDED BY AVERAGE

Scarcity Index Components By River Basin

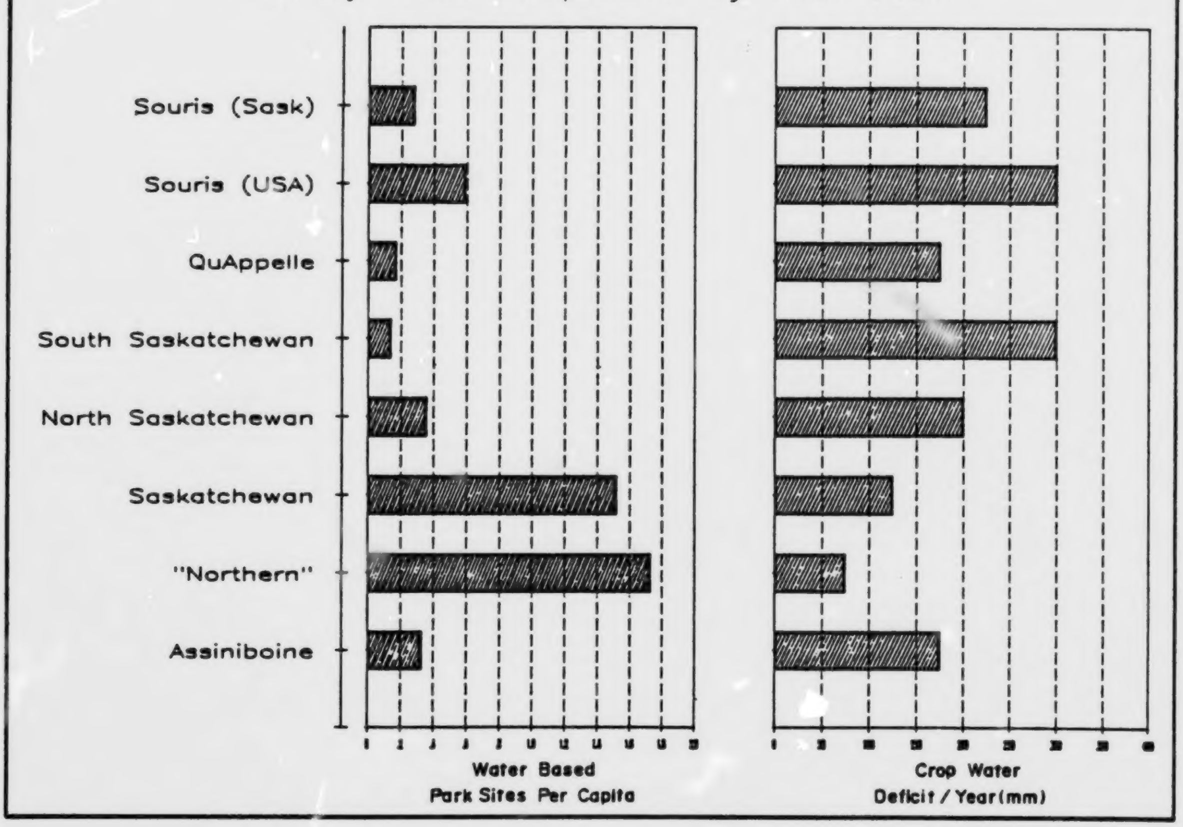


Scarcity Index Components By River Basin





Scarcity Index Components By River Basin



Scarcity Index Components By River Basin

Conclusion

Although crop water deficits are above normal, it appears that the major impact of water deficiencies in the basin are related to industrial and recreational/sociological opportunities. As the various measures of water scarcity are analyzed, the Souris Basin is continually ranked as one of the most water deficient areas. The U.S.A. portion of the basin demonstrates more intensive management than the Saskatchewan portion of the Souris basin. Water is currently underutilized in the Saskatchewan region and intelligent water management must play a key role in the regional development opportunities for the basin.

5.0 QUALITY OF LIFE

5.1 Introduction

The Rafferty-Alameda reservoirs will create a major change in Saskatchewan's water resource profile. Rafferty will be the third largest artificial impoundment in the Province.(9) Alameda, at one-third the size of Rafferty, will be the second largest reservoir in the Souris River Basin. The quality-of-life oriented impacts will be regional, affecting the southeast corner of the province. Costs to the quality of life will be largely a disruption of the existing business, and social services, and population dynamics patterns. Services and populations will grow because of the dams, with the anticipated growth leading to the above disruptions. Benefits will arise from the new opportunities created by the growth.

The traditional components of quantitative socio-economic analysis were covered in the previous section. The purpose of this section is to review those issues which have a major impact on the region and are most probably the real basis underlying individual support and concerns over the proposed project. The issues to be reviewed include aesthetics, regional pride, cultural heritage, social interaction, and community stability and development. Discussion of the issues are based on analysis of similar projects in other areas, as well as community concerns in southeastern Saskatchewan.

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(9) It will be one-tenth the size of Lake Diefenbaker and one-sixth the size of Tobin Lake.

5.2 Aesthetics

Water is so critical to the survival and development of an arid region that water inspires an elevated status of emotional or spiritual respect.

The aridity of southern Saskatchewan was recognized by early explorers as a severe limitation to development and population growth. The suffering of malnutrition and family upheaval caused by the drought years of the 1930's emphasized these observations and formed an indelible mark on the conscience of the province. This has led to an implicitly high value attributed to water development projects. Initial economic analyses of Diefenbaker Lake, for example, indicated benefit cost ratios of less than unity, yet public decision makers for the project continued. The rationale for the project was couched largely in non-specific values such as regional economic and social stability, new recreational resources, and long term prosperity of regional communities. Additional water supplies to the current secure level of supply would allow for more development which, in turn, will create a more positive social and investment climate. Families and investors would both be more likely to put down roots, to invest their time and effort for the long term.

The creation of lakeshore vistas is important to Saskatchewan residents with the propensity to "cottage" on a suitable lakeshore - a high priority to recreationists. This trend is being emphasized in urban areas with recent real estate development patterns in Regina. Artificial lakes and a proximity to Wascana Creek have come to dominate the design of new subdivisions.

While efforts such as the Prairie Wildlife Interpretation Center of the Canadian Wildlife Service near Webb, Saskatchewan, have raised our appreciation for the flora and fauna of the prairies, there is no doubt that wetlands are more fertile than arid zones. Biomass measures are higher and species diversity is greater. Higher biomass measures offer more opportunities for human involvement.

One of the major aesthetic costs is the period of limbo between valley clearing and full reservoir development, with its accompanying recreational facilities. The construction period will increase traffic flows and the presence of non-locally oriented populations. There are costs to these increased activities such as accelerated deterioration of road services and decreased regard for community values. In the longer term, increased activities associated with dam construction will provide an accelerated demand for local housing and services.

5.3 Cultural Heritage

In the process of investigating the project, archaeological research has identified campsites where artifacts have been discovered, examined and classified. (See Archaelogical Section of E.I.S.) These aboriginal sites were very common throughout Saskatchewan, but as more land is developed, these sites are obliterated, with the remaining sites becoming more important in analyzing the region's history. The increase in knowledge and awareness add to our land's cultural heritage and are benefits of studying the feasibility of the project, not the construction itself. The benefits arising from construction will be the increased pressure to capture the available archaeological information quickly. The project will make more dollar resources available to complete a job in a few years which would normally have occurred over many years. The information and knowledge gained from this intensive activity can then be applied to other archaeological sites and tourism potential in the province. In addition, the pressure to preserve the aboriginal heritage of the reservoir sites may be the stimulus for the organizational effort required to develop a formal cultural preservation and interpretation facility.

Our more imminent heritage is centered around a rural non-irrigated cereal agrarian economy. The increase in irrigation development will provide incentive for the continuation of an agrarian heritage. Should the irrigation potential be used for forage production and an increase in livestock activities, the rural population will tend toward a year-round on-farm lifestyle. The seasonal stabilization of the total population, coupled with increased industrial development, will tend to stabilize business and service industry clientele from the "go south for the winter" attitude of rural cereal producing areas.

5.4 Recreation

The economic analysis of recreational costs and opportunities in the economic analysis included only the least amount people are willing to pay for recreational opportunities. People are willing to pay more, with some estimates at twice the amounts assumed in the economic analysis. The opportunity for recreation is a component of the intra-sociological makeup of peoples' environment. The existence of recreational opportunities reflects on a community's positive attitudes and community spirit. This is reflected in the large investments in recreational facilities at isolated locations where the opportunity for outside recreation is limited. Publicly supported recreational facilities are a component of our cultural expectations and, consequently, the amount people are willing to pay often undervalues recreational opportunities to a region.

An additional benefit resulting from the proposed project would arise from the relief of pressure on existing recreational resources in the Moose Mountain area. The Rafferty Reservoir will be within range of evening boaters from Estevan and Weyburn whereas Moose Mountain lakes are not. There will, therefore, be some incremental water based recreational activity on the Rafferty reservoir. Provision of alternate fishing and boating resources may result in a drop in use of the Moose Mountain facilities, which will increase the value of a recreation day at those resorts. That is not likely to take place in a short period of time, since the development of aesthetically pleasing alternatives on the Rafferty reservoir will take several years.

The Rafferty reservoir will inundate both Dr. Mainprize Park and the Lutheran Bible Camp. The Dr. Mainprize facilities are a testimonial to community spirit and service. These facilities are nearing the end of their life cycle and are in need of major rehabilitation. Project intentions are to remove the essential and sentimental components of the original facility to a new location, and develop the facilities beyond those of the original park. Although the site will be changed, the facilities will stand as a testimonial to future generations who are not sentimentally attached to the original site.

5.5 Regional Pride

Many of the more intangible benefits of water resource developments can be summarized through their influence on regional pride. Several communities, including Regina, have been stigmatized for their poor water quality. Removal of those stigmas allows a flowering of community pride, which can lead to several important benefits. Releasing the negative self-images associated with drought and poor water quality, especially when those stigmas have become widely acknowledged, releases a great deal of optimism and enthusiasm, through the process of eliminating or reversing a deeply felt weakness.

Improved water supplies, in both quantitative and qualitative senses, can change a community's self-image. During the construction period and for several years thereafter, there can be a noticeable improvement in civic spirit. While that change in spirit has many tangible consequences for the material quality of life, it is perhaps most important for residents' sense of confidence in, and satisfaction with, their community and themselves.

The sense of progress engendered by undertaking challenging and visible projects is another important intangible benefit. The Gardiner Dam, and many others like it around the world, have served to convince communities that they are indeed capable of great things, of growing beyond their existing capabilities. In the process, those communities develop important skills in construction, management, and operation of large projects. Those skills may produce additional benefits if they can be exported in services, but their most tangible result usually comes from the expanded vision and confidence of the local people associated with the project. They have proven to themselves that they can accomplish something bigger than ever before attempted.

The identity of the community changes as it proves it can accomplish major projects. When those projects also dramatically change the amenities of the community and its perceived quality of life, the combination produces an enthusiastic upwelling of confidence and pride. Under those circumstances, both the perceived and actual quality of life improve dramatically.

Some problems have been experienced where the boom and bust cycles, and altered economic activities, associated with major construction projects have been disruptive to the local communities. In the case of the Rafferty and Alameda projects, this will not be the case. The construction crews entering the community will be noticeable, but will hardly dominate the area. The southeast part of the province has hosted several major construction projects over the years and will likely continue to do so in the future.

Saskatchewan has a long history of water resource development. Lessons from that experience mean that both residents and administrators should be prepared for most of the situations which arise.

5.6 Water Supply Changes

A contingency allowance for mitigation of rural ground water was included as a project cost in the economic component of this study. However, the opposite spectrum of ground water enhancement is expected to occur. As the water table moves upward around the reservoir, hydrostatic pressure will improve local wells. Supply will become more plentiful.

Although increased flow rates are generally expected to reduce the level of mineralization and improve the quality of water, the ultimate quality will depend on the ground through which that water moves. Supplies will become increasingly secure, and nearer to the surface as the reservoirs fill.

Surface water will also become more plentiful. Water quality within the reservoirs will almost certainly be an improvement over slow moving summer river waters and the relatively small impoundments currently within the reservoir areas.

5.7 Flood Protection

The qualitative project evaluation component of this study captured some of the qualitative benefits associated with flood protection. Yet the standard financial values do not accurately reflect the various dimensions of flood protection. The estimation of flood damages by the depreciated value of goods grossly underestimates the human suffering caused by the loss of cherished household effects. Because of the history of frequent flooding and of wide ranges in flow, land development within the Saskatchewan portions of the river valley is very limited.

While communities of the Souris basin are generally located close to the river, few exhibit significant emphasis on waterfront development. Given the high cultural importance attached to water on the prairies, one can conclude that the absence of such developments in Estevan stems, at least in part, from the dangers of flooding.

Elimination of that danger will likely lead, over time, to enhanced development of recreational resources along the waterfronts. Golf courses, parks, playing fields, etc. all make good use of a flood plain. The advantages of that sort of development in arid Saskatchewan are especially strong, since the combination of a steady source of irrigation water with the more fertile soils within the river valley allows development of proven recreational resources and will strengthen the aesthetic qualities of life considerably.

5.8 Impacts from Economic Changes

Economic growth has numerous implications to the quality of life. A wealthier society is generally presumed to be happier than a poorer society.

On the other hand, economic growth implies change which people often find disruptive. Benefits accrue to those who adapt to the changes, while those who do not generally lose their community stature.

Regional expansion means greater support for advanced services within the fields of education, medicine, and transportation. Many services require certain population and economic activity levels as a necessary economic threshold to entry. The attitudes associated with a growing community and service base creates an attractive atmosphere for other services, in anticipation of continued growth, to become established. Families are also encouraged to put down deeper roots if they expect a growing number and variety of opportunities for themselves and their children.

The Alameda and Rafferty dams are part of a larger scale economic development plan. Their implementation will allow a continued diversification between and within agriculture and industrial development.

The industries most directly served by the Shand-Rafferty-Alameda project are natural extensions of the existing economy. The impacts, skill requirements, and opportunities are therefore well understood. The community will graft them onto existing patterns of behaviour more readily than it might with less-well-understood economic activities.

The dams also create some opportunities which complement existing activities. The interest in recreational water bodies and the interest in environmental and cultural heritage can be served through the elaboration of such mitigation measures as regional parks and interpretation centres. Those facilities will, in turn, create their own form of economic diversification, offering jobs in the recreation, tourism and cultural fields.

Increased employment means population growth, and increases in associated services. Further employment impacts will be created through spinoff activities. In the long term, population numbers will probably return to a lower level, but the attendant infrastructure will have already been developed with a major portion of it remaining.

5.9 Summary of Quality of Life

Some recreation opportunities may be temporarily curtailed during the dismantling of current facilities and the necessarily slow development of alternatives. The lack of water based recreation opportunities in the basin now suggests the wait will be worthwhile. The reservoirs will be a source of regional pride for our water oriented culture.

Disruption of land use patterns will result in some population turnover. The expanded population base and accompanying economic opportunities will provide a stabilizing influence on local communities. The surge in regional economic opportunities will create the opportunities for improved transportation, cultural facilities and recreational opportunities in the area.

6.0 ECONOMIC ANALYSIS

6.1 Introduction

Benefit/cost analysis requires a detailed appraisal of all beneficiaries and the total costs arising from a project. Only those benefits and costs which are readily quantifiable are included in the following economic analysis. Other identifiable benefits and costs are included in the analysis entitled "Quality of Life." Quantified benefits have been identified under the categories of direct, forward and backward linkages. These benefits are clearly distinguished in the benefit/cost ratio, allowing the reader the opportunity to choose the benefit/cost ratio formulation most appropriate to a particular accounting stance.

6.2 Direct Benefits

.1 Agricultural Benefits(1)

Agriculture is one of the intended major beneficiaries of the proposed Rafferty-Alameda projects. Although some irrigation is occurring in the river basin, available water for irrigation is limited and highly variable (see water scarcity index and Socioeconomic Section E.I.S.) during the season and over the years. The Rafferty and Alameda reservoirs will provide a more reliable water supply, which will allow for significant increases in irrigated acreages within the river basin.

In general, a corridor of agricultural land, several kilometers in width and following the Souris River upstream of Estevan, is of poorer quality land with predominance of Class 3 and Class 4 land.(2) The land could be irrigated, but extra managerial attention is required to overcome the limitations of the soil. Land quality improves along the Souris River below Estevan particularly in the low land areas and this land has the highest probability of being irrigated.

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(1) The analysis of agricultural benefits was taken directly from the WRC report.

The uplands surrounding the Alameda Reservoir are general much more suitable for irrigation than the Rafferty uplands with a predominance of Class 2 and Class 3 soils. The valley bottom lands below both reservoirs are also predominantly Class 2 and 3 soils and, overall, are more favorably suited for irrigation development than the Alameda uplands.

Crop water demand consists of several components, namely, the net of effective precipitation and crop requirements for water, operational wastes arising from the operation of the irrigation delivery system, on-farm losses such as wind drift and surface runoff, and water surges required to leach salts, etc., down out of the root zone. Actual annual water demands will vary depending on the amount of rainfall and the amount of crop heat units occurring through the growing seasons. Estimated crop water demands are as follows:

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(2) Irrigability class with Class 1 - Excellent; Class 2 - Good; Class 3 - Fair; Class 4 - Poor.

Table 2: Estimated Crop Water Demands

Water Requirement	Uplands Peak Year(mm)	Lowlands Peak Year(mm)
Irrigation demand	310	260
Operational waste	10	0
On-farm losses	100	30
Leaching	30	10
TOTAL	450	300

Smaller irrigation projects along the valley floor do not require operational waste plus most farm wastes return directly to the river. Consequently current Saskatchewan Water Corporation policy is to license lowland projects for approximately 300 mm of water. In order to meet crop water demand 100% of the time, a total of 450 mm of irrigation water must be available for each unit of irrigated land during each irrigated season. In practice, irrigation systems are designed and irrigation rights are allocated such that irrigation demand may not be met by available supplies in all years. For example, the general stated policy of the Environment Council of Alberta is to ensure that at least 75% of irrigation water demand is met each year and Sask Water considers 70% availability in irrigation project assessment.

Basin water yields available for irrigation were estimated, based on PFRA's hydrology models and water management strategy assumptions, as stated earlier, to be 5,630 dam^3 one hundred percent of the time, and 32,970 dam^3 at least seventy percent of the years. If only seventy percent of total water demand is met, it is projected that over six times the acreage can be irrigated. Because of the significant increase in potential acreages and because of similar operational policies elsewhere, agricultural benefits are based on the seventy percent alternative. Given this alternative, it is assumed that 8,000 acres (5,000 below Rafferty and 3,000 below Alameda) of irrigation will be developed in the river valleys downstream of the reservoirs, and 4,000 acres will be developed on the uplands surrounding the Alameda Reservoir.

The lowlands are favored for irrigation development over the uplands because of lower unit costs for developing irrigation systems, higher water efficiencies, higher irrigability classification of valley soils, and the lack of organization required to establish cooperatives necessary for larger scale upland development. Consequently the lowland areas are expected to develop to their full potential while upland development will be limited.

Benefits accruing to agriculture depend on the changes in agricultural activities brought about by the creation of the reservoirs. Irrigated agriculture techniques will replace non-irrigated techniques on a major portion of the potential 12,000 acres.(3) Current land use patterns document the current utilization of the land being replaced, whereas only subjective estimates of potential irrigation uses can be made.

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(3) See discussion of the potential loss of irrigation land in Section on Agricultural Costs.

As a basis for evaluating potential uses of irrigated land, two irrigated land use patterns were developed as potential scenarios for the future.(4) A distinct land use pattern was established for the lowland areas but since there were no assumed alternate use patterns for the lowlands only two scenarios or options are available. The land use patterns chosen for the uplands area as most applicable to the Souris basin are a cereal-grain and livestock forage oriented irrigated agriculture. All lowland development is assumed to follow a set pattern..

The grain scenario assumes an irrigation development similar to that as exists in the South Saskatchewan River Irrigation District today. The scenario reflects relatively high proportions of cropland devoted to cereals and oilseeds, with relatively minimal numbers of livestock and specialty crop farms.

The livestock scenario assumes development of the irrigated area similar to that of the four major irrigated areas in Alberta, where livestock oriented farms form a major component of the land base.

The lowland use pattern does not include specialty farms and includes a high portion of hay in support of local non-irrigation based livestock herds.

Land use patterns for the two scenarios plus the lowland patterns are demonstrated in Table 3.

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(4) Previous irrigation project appraisal studies were based on large track developments where economics of size and large proximate urban centers allowed for more comprehensive irrigation based industrial development.

Table 3: Land Use Patterns

	Upland		
	Grain	Livestock	Lowland
Forages and Pasture	14	27	28
Wheat	53	36	45
Other Cereals	9	24	5
Oilseeds	14	5	14
Specialty & Vegetable	6	6	0
Summerfallow	4	2	8
TOTAL	100%	100%	100%

Expected agricultural prices were adopted from previous studies.(5)

These prices are based on mid-range historical commodity prices in 1984 dollars. The prices were derived to reflect long-range expected prices over the life of the project. Agricultural commodity prices have continued to feel downward pressure and the agricultural community appears to have become more pessimistic. In light of this pessimism, 1984 commodity dollar values were not indexed to 1986 dollars as per the other components of this analysis. Base prices and yields assumed for this analysis are shown in Table 4.

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(5) Saskatchewan Irrigation Project Appraisal Study, Saskatchewan Water Corporation and Prairie Farm Rehabilitation Administration.

Table 4: Base Case Yields and Prices

	Yield	Price
Soft Wheat (bu)	76	$4.90
Barley (bu)	87	2.60
Canola (bu)	39	7.50
Alfalfa (ton)	3.95	87.00
Slaughter Beef (cwt)		79.00

The above yields are based on 100% water availability. The substantial increase of potential irrigated acres associated with the 70% of total demand policy is not without some costs. Water shortages will marginally reduce crop yields and profits on individual acreages, while the overall production and profit output over the region will increase because of the expanded acreage. It is assumed that the farm operators are able to anticipate the water shortage and alter their planting and crop management strategies to account for it. This will minimize the negative impacts of water shortages on individual farmers.

Increased yields under irrigation, given the above price assumption, translate into benefits to the farmers. One measure of these benefits is the return over cash costs (excluding capital costs). This is a measure of return for family and operator labor, management and capital investment. However, the measure is not identical to net income as is commonly used in farming circles. For the sake of convenience the above measure is estimated as the incremental change under irrigated conditions over and above that under dryland conditions.

Incremental returns over cash costs are calculated for three production scenarios: i) river valley land, ii) Alameda uplands under grain production, and iii) Alameda uplands under livestock production. These estimates are shown in Table 5.

Table 5: Incremental Returns Over Cash Costs for Irrigation, Dollars per Acre

	----- Dollars -----		
	River Valley	Alameda Uplands	
	Lands	Grain	Livestock
Gross Revenue	354	315	596
Cash Costs	238	189	438
Return Over Cash Costs	116	126	158
Return Over Cash Costs including government subsidies for irrigation	168	178	212

The highest return over cash costs occurs with livestock production with $158 per acre over and above that which would have occured under dryland conditions.

.2 Recreational Benefits

Recreation is expected to develop at a constant rate to full development at 10 years after dam construction.

Recreational benefits are difficult to quantify. It is an accepted philosophy that public recreational opportunities be available at minimal costs. Consequently, the recreational market has never been able to fully analyze just what the public would be willing to pay or what the true worth of the recreational facilities are.

The true value of recreation is a function of the number of visitor days and the amount that the visitors would be willing to pay. This analysis accordingly is composed of measuring visitor days attributable to the various recreational opportunities, and assigning a value to these visits. See Recreation Appendix for more detail on recreation benefits.

Souris River valley public recreation facilities upstream of Estevan are limited to a local regional park, which is dedicated to the memory of Dr. Mainprize. The park consists of picnicking, camping, playground, swimming and golf facilities. The park is largely depreciated, with current annual visitor days at approximately half the number of visitors during the 1960's. Although the residual value of the facilities is relatively small, the facility represents a significant portion of local recreational opportunities and similar opportunities must be maintained after reservoir development.

Project plans include extensive upgrading and expansion of the Dr. Mainprize facilities at a new location. The new Dr. Mainprize facility will include a nine-hole golf course, swimming, picnicking, a marina, a campground and the relocation of the unique Dr. Mainprize structures. It is anticipated that the upgraded facility will attract a number of visitors similar to that of the 1960's, when the current facilities were new. Visitor days for the Dr. Mainprize facilities are expected to be between 70 to 90 thousand per year.

The detailed plans for the mitigation and relocation of the Dr. Mainprize Regional Park are described in detail in the Environmental Impact Statement. Plans for mitigating lost wildlife habitat and the enhancement of alternate wildlife habitat and fisheries capabilities are also described in detail in the main E.I.S. reports.

In addition to the Dr. Mainprize recreational facilities, a park is planned for the southeast end of the Rafferty reservoir. This park will be closer to Estevan and will attract more day users than the more remote Mainprize facility. The south Rafferty facility will include playground, sports fields, interpretive facilities, hiking trails, boat launches and a campground. Visitor days for this facility are also estimated at 110,000 to 130,000 days.

A recreational facility is also planned for the Alameda reservoir. This facility together with Rafferty is expected to remove some of the recreational pressure from the Moose Mountain resort area and attract 20% of its visitors from the U.S. Allowances were not explicitly made for the displacement of Moose Mountain visitors to Alameda; rather, it is anticipated that the increase in recreational value from reducing the congestion at the Moose Mountain facility would be offset by assuming the visitors at the new Alameda facility to be newly created visits, and not displaced ones. Annual visitor days for the Alameda recreation facilities are estimated at 60,000 to 80,000 visitor days.

Good cottaging opportunities within the Souris basin are very limited. Cottaging is popular in the Moose Mountain area, but public facilities are often overcrowded. Some cottages (approximately 50) have been developed on the Boundary Reservoir, but the opportunities and aesthetics of locating there are very limited because of the Boundary Dam Power Station. The creation of the Rafferty and Alameda reservoirs will create a dramatic increase in cottaging opportunities. It is estimated that a maximum of 175 cottage sites (125 or the lower reaches near Estevan and 50 near Dr. Mainprize Regional Park) will be developed on the Rafferty reservoir, and a maximum 100 cottage sites will be developed on the Alameda reservoir. The cottage sites will attract 65,000 and 30,000 visitor days to the Rafferty and Alameda reservoirs respectively, in addition to those visitors already visiting the developed public recreational facilities.

Nonconsumptive recreational opportunities are comprised mainly of sightseeing trips. Stops are not necessarily made at any of the recreational facilities, but the panorama does contribute to the demand for such activities. It is anticipated that the participation in this particular activity will increase from current participation rates because more people will stop and utilize the facilities. It is expected that this activity will realize a net gain of 1500 recreation days per year during and after reservoir construction.(8)

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(8) This is to occur over the life of the project and may not toally capture the sightseeing activities which will take place during dam construction.

Recreational and hunting data from North Dakota indicated a significant increase in waterfowl hunting opportunities from reservoir construction. This increased opportunity, arising from construction of the Rafferty-Alameda reservoirs, will result in an increase of 3,000 days of waterfowl hunting in the area.

This increase represents a possible shift from big game to waterfowl hunting. Recreational days, which are directly attributable to the reservoir development and will occur in each year once recreational facilities have been fully developed, are summarized in Table 6. (See Recreational Appendix and Outdoor Recreation Enhancement E.I.S. for background detail).

Table 6: Recreation Days per Annum After Full Development

Dr. Mainprize Park	80,000
Rafferty South Recreation	120,000
Alameda Recreation	70,000
Dr. Mainprize Cottaging	15,000
Rafferty Cottaging	37,000
Alameda Cottaging	30,000
Nonconsumptive Use	1,500
Hunting	3,000
TOTAL	356,500

The value of a day of outdoor recreation is difficult to measure. Expenditures per visitor day for various activities, sales of recreational equipment, travel costs, and hunting and fishing license sales are all used as indicators of the publics' value or willingness to pay for recreational facilities. Expenditures do not necessarily reflect the maximum or total value to a recreationist, but a value that they would at least be willing to pay. In fact if the price of recreation consumption increased dramatically, many people would still be willing to participate.

The value of a recreation day was categorized into costs paid by the recreators and their total willingness to pay for an equivalent amount of recreation. (See Annex in Recreation Appendix for more detail). Recreational expenditures per day were estimated via unpublished data of actual expenditure patterns of visitors to general recreational sites within the South Saskatchewan River Basin in Saskatchewan (University of Saskatchewan). Questionnaire data from two provincial parks were considered similar to that which would occur in the Souris basin. Cash expenditure data for Douglas and Danielson recreation facilities averages $12.40 per visitor per day. Estimates of recreational equipment expenditures indicated a total value of $8.63 per visitor day for a total value of $21.03 per visitor per day. On the average, a visitor is willing to pay at least this amount for a recreational day.

An outdoor recreational benefit study conducted in relationship to birdlife by the Institue of Northern Studies for the Canadian Wildlife Service utilized a questionnaire to determine the value of outdoor recreation to a cross section of Saskatchewan residents (SRBS, Supplement 5, Related Resources Study - Saskatchewan, Blood & Assoc., 1977) Average benefits for a recreation day were estimated to be $15.46 in 1974 dollar values. This figure adjusted to 1986 dollar values via the consumer price index is $39. per day.

Based on the above estimates the net benefits accruing to a Saskatchewan resident from one day of outdoor recreation is $18 per day. Because operation and maintenance costs of the recreation facilities are included in the benefit cost analysis as a project cost a $3 per day user fee for the recreation facilities has been added to the $18 to avoid double counting in the analysis. For the purposes of this report, outdoor recreation is valued at $21 per day.

.3 Benefits to Thermal Generating Plants

One of the primary purposes of the dam is to develop a water supply to be used as a cooling medium for the proposed Shand Power Station. Development plans are for two 300 mW power units to be installed. Both power units are to be cooled by water from the Rafferty Reservoir. Saskatchewan Power Corporation estimates the value of the first power unit is $20.3 million dollars. Given the fact that a specific in-service date for the second unit at the Shand Power Station has not been determined, a precise monetary value for the second unit has not been assigned.

Based on the above estimates the net benefits accruing to a Saskatchewan resident from one day of outdoor recreation is $18 per day. Because operation and maintenance costs of the recreation facilities are included in the benefit cost analysis as a project cost a $3 per day user fee for the recreation facilities has been added to the $18 to avoid double counting in the analysis. For the purposes of this report, outdoor recreation is valued at $21 per day.

.3 Benefits to Thermal Generating Plants

One of the primary purposes of the dam is to develop a water supply to be used as a cooling medium for the proposed Shand power generating plant. Development plans are for two 300 mW power units to be installed. At least one power unit is to be cooled by water from the Rafferty Reservoir. All other power units in Western Canada are water cooled and the preference of Sask Power would be to continue with this technology. However, sufficient water may not be available and the single air-cooled unit can be viewed as an experimental unit. The power unit's efficiency is affected by contrasts in temperature and since water is a more efficient temperature transmitter, the water-cooled technology is a more efficient producer of energy. As the air-cooled process is less efficient, the Saskatchewan Power Corporation has discounted to present value, the savings in coal fuel, considering all other costs, which would accrue back to a water-cooled power unit over an air-cooled one for an assumed future power demand scenario. Saskatchewan Power Corporation estimates the value in savings of the one technology over the other for one power unit is $20.3 million dollars.

.4 U.S.A. Flood Control

Spring flows in the Souris river frequently cause flood damage in both Saskatchewan and North Dakota. The river valley in the North Dakota is relatively shallow with extensive urban developments on the flood plain. The opportunities for flood control in the Minot area are seen to be expensive and not entirely effective.

Dams on the Souris River and Moose Mountain Creek are far more cost effective than the U.S. options for similar flood protection. It is, therefore, in the interests of the U.S. to contribute to the construction of the proposed (U.S.) projects in Saskatchewan. Negotiating teams have been seeking cost sharing and reservoir operating schemes which are mutually beneficial. A major contribution of $41.1 million, October 1985 dollars, in U.S. currency has been negotiated as the U.S. contribution to the project. This value is assumed in this study to equal U.S. benefits arising from flood control.

.5 Saskatchewan Flood Control

Flooding of the communities and farmlands in the Souris River valley has historically been perceived as a serious problem by many valley residents. The Souris River Basin Study utilized established depth damage curves for residential and commercial damages combined with locally generated assessments of rural crop losses and damages to roads and bridges to estimate Souris Basin flood damages. Flood damages that would be partially mitigated by construction of the Rafferty and Alameda reservoirs are:

Urban: R.M. of Estevan No. 5
Village of Roche Perce
Oxbow
Rural: The Souris River valley to the
international border.

The areas to be inundated by the reservoirs are also considered to be mitigated by flood damage, as they will be purchased by society and altered to become a component of the reservoir designed to be flooded.

It is estimated that the two reservoirs and diversion channel will significantly reduce downstream flood damage within Saskatchewan. Estimated annual benefits of flood mitigation are outlined in Table 7:

Table 7: Annual Flood Mitigation Benefits

Urban:	
Estevan	21,700
Roche Perce	8,830
Oxbow	570
Rural:	
Lost production	100,500
Dwellings	7,600

Total annual average benefits $139,200

.3 Project Costs

.1 Agricultural

Agricultural project costs consist of the capital costs of irrigation system development with annual operations and maintenance, and of land lost to agriculture from reservoir inundation.

Capital cost estimates for irrigation development on 12,000 acres of land are shown in Table 8.

Table 8: Capital Cost Estimates For Irrigation Development

		Cost in Thousands of Dollars			
Location	Irrig. Area (Acres)	Main Pump Station	Distrib. System	On-farm	Total
Block Irrigation					
Alameda Upland	4,000	3,604	4,185	2,798	10,587
Lowland Irrig.	8,000	1,312		5,861	7,173

Main pump stations include the pumping facilities to pump water from the reservoirs to supply the upland areas. For the lowland irrigated areas, the main pump station category refers to the rock weirs constructed in the river to facilitate the pump intakes.

The distribution system delivers water via pressure pipe or canal networks to the irrigated land parcels. The on-farm capital costs include pumping units, if required, mainlines and sprinkler laterals. The "other" category includes contingencies and engineering costs.

On-farm capital costs required to develop irrigation, in addition to irrigation equipment, are as follows:

Table 9: Marginal Cost of Converting an Acre of Dryland into Irrigated Land, by Economic Development Scenario ($/Acre)

Scenario	Farm Machinery	Buildings & Storage	Vehicles	Total
Alameda Upland				
Grain Scenario	261.97	73.73	51.40	387.10
Livestock Scenario	156.08	66.84	70.11	293.03
Lowland	225.97	71.39	57.76	355.12

Annual operations and maintenance costs, excluding on-farm costs for the project, are as follows:

Table 10: Annual Operations and Maintenance Costs (Excludes Cost of On-farm Works)

	Acres of Irrigation	Total Cost In $1,000
Block Irrigation		
Alameda Upland	4,000	184.4
Lowland Irrigation	8,000	9.9

Agricultural land will be lost to inundation by both the two reservoirs, and to services and recreational facilities. Land losses are as follows:

Table 11: Agricultural Land Losses to Project Development[7]

	Acres
Rafferty Reservoir	9,670
Alameda Reservoir	4,830
Dr. Mainprize Recreation	320
Rafferty Recreation	160
Alameda Recreation	160
Services and miscellaneous	60
TOTAL ACRES	15,200

Not all of the above acreages are currently used for agricultural production. Although current institutional or economic conditions preclude their use in agriculture, they are available if these limiting conditions change. Reservoir construction, on the other hand, will permanently remove this land from the agricultural resource base and its alteration is thus a cost to agriculture. The above land base applies only to land lost and does not include severed land parcels remaining uneconomic farm units, etc. These uneconomic land parcels have not been lost to agriculture, but because of institutional and economic constraints, a certain social cost will be incurred by the owner. The social costs are estimated via those costs paid by the Authority to the landowners in excess of the appraised market value of their properties.

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[7] This excludes land not useable for agriculture, such as gravel pits, river and water surfaces, wetlands, buildings, etc.

Approximately 1,960 acres are currently irrigated in the Souris River Basin area, with the majority being in the Souris River and the Moose Mountain Creek valleys. Some of this irrigated acreage does lie within the reservoirs' flooded area; however, water supply and an unsuitable irrigation land base are the limiting factors to irrigation development in the basin. Therefore, creation of the reservoirs will relocate irrigable acreages, rather than decrease them. There are definite social costs associated with this transfer, but agricultural production capabilities within the basin will not be reduced. Agricultural production may, in fact, be increased.

Irrigability classifications indicate that general soil capabilities in the Rafferty reservoir areas to be less than those in the downstream valleys and on the Alameda uplands. Because the reservoirs will not reduce the potential irrigable acreages within the river valleys, the overall agricultural capability lost to the project is non-irrigated land. Annual revenue returns to each acre of cropland lost to the project are $8.94 per acre.(8) The returns to each cow/calf unit, excepting summer pasture costs, are $66.38. The pasture capabilities of the lost lands is highly variable because of the varying terrain. Capacities were estimated at 15 cow/calf units per quarter section per grazing season. The estimated average annual net loss to the 15,200 lost acres is $6.68 per acre. If this return were expected over the 50-year life of the project, at a discount rate of 5%, the present value per acre for the lost agricultural land is $122.00 The present value should reflect the current economic market value of an average acre of land lost to agriculture. Given the combinations of valley slopes and better bottom lands, this appears to be a reasonable estimate.

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(8) This is return to land base after all cash costs and overhead costs have been paid.

.2 Recreation

Recreational costs include both mitigation costs to replace lost facilities and enhancement costs, which reflect the opportunities arising from the project to further develop the recreational opportunities within the basin.

Dr. Mainprize Regional Park is the major established recreational facility within the reservoir areas. The park is nearing the end of its current life cycle and will require intensive rehabilitation and development to maintain its previous importance as a significant regional recreational facility. Annual visitor days were estimated to be 60,000 during the 1960's. Current visitations are approximately 14,000. A base of 25,000 visitor days was assumed as the total number of visitations lost to the current facility. An estimated 80,000 visitor days are estimated for the new facility for a net gain of 55,000 visitor days. It will cost $600,000 to mitigate or replace the current depreciated Mainprize facilities. Annual operations and maintenance costs necessary to maintain the facility without further depreciation are estimated at $90,000.

Capital costs required to rehabilitate the current park facilities are estimated at $920,000, plus a 10 year maintenance trust fund of $200,000, with annual costs of $138,000.

An additional recreational site has been proposed for each of the two reservoirs. Capital costs are estimated at $2,690,000 with annual costs of $403,500 for the Rafferty site near Estevan. Capital costs are estimated at $1,200,000 with annual costs of $180,000 for the Alameda site.

Reservoir development will create opportunities for cottage development. Cottage recreational costs are categorized into land development, cottage construction, and annual operations and maintenance costs. Although some cottages may be permanently occupied only those costs and benefits equivalent to recreational cottages are assumed as recreational costs and benefits. Land development costs are estimated at $7,000 per site. These costs include survey, road construction and utility service costs. The average value of cottage construction costs are estimated at $30,000. This value does not include the sweat equity of the owners. Annual operation and maintenance costs are estimated at $1,110 per cottage.

Opportunities are being sought by the Souris Basin Development Authority to enhance wildlife opportunities. It is estimated that some wildlife will be lost because of the loss of critical wildlife habitat. This loss, in part, will be replaced by development of upland and waterfowl related facilities near the proposed location of the new Dr. Mainprize Park and elsewhere. The waterfowl facilities will mainly be comprised of earth retaining berms, and water control structures to maintain constant water levels, and fencing etc. for human and predator control. Estimated costs for the wildlife habitat enhancement facilities will be $3,305,000 with annual costs of $15,000.

The reservoirs will also provide opportunities for developing a fishery. Fisheries enhancement is proposed for the Rafferty reservoirs. Construction costs are estimated to be $650,000, with annual costs of $21,000.

.3 Water Resources

It is anticipated that reservoir development will affect groundwater movement and, possibly, groundwater quality. In isolated cases, incurred mineral contaminants may be washed into rural wells. The extent of beneficial and/or detrimental effects has not been analysed, but contingency funds of $60,000 and $315,000, for the Alameda and Rafferty areas, will be set aside for mitigation, if required.

It water quality is adversely affected, continued treatment may be required and annual funds of $3,000 and $15,750 have been designated for this.

The Hitchcock and Midale community water intake structures will be inundated by the Rafferty reservoir. Mitigation costs have been allocated to move the intakes to above the reservoir full supply level. No annual costs have been designated, as the required lift will be reduced and reservoir water quality will improve over the relatively small impoundment currently utilized.

.4 Oil Well Mitigation

Both reservoirs will inundate operating oil wells. The oil fields are predominant in the Rafferty area and are located at the upper end of the reservoir area. These fields, in general, are also in the latter part of their life cycle. Some of the higher elevation older wells will probably be depleted before reservoir waters reach them. Earthen berms and/or man-made islands for some of the higher wells will suffice to mitigate flooding from reservoir flooding. Others can be flood proofed to permit temporary interruption of production. Wells in the deeper part of the reservoirs can either be bought out or redrilled at an angle from the shore. Each site should be individually assessed. In addition, it will be several years before waters reach the higher wells; consequently, oil well mitigation estimates are not finalized. Preliminary estimates suggest costs of $4,055,000 for Alameda and $18,165,000 for the Rafferty reservoirs.

.5 Other

The reservoirs will necessitate power line relocations and reconfigurations. Currently, power lines traverse the valleys on regularly spaced poles. The transmission lines may need some minor relocation to utilize the narrower sections of the reservoirs and tower structures on each shore are required to traverse the reservoir. Power line relocations are estimated to be $600,000 and $300,000 for the Alameda and Rafferty reservoirs respectively.

Several local rural and grid roads traverse the valleys in the reservoir areas. Some of the minor roads will be closed and the major grid roads will be developed and/or upgraded to accommodate the extra traffic from the reservoirs and from closed roads. Bridges will be required to cross the reservoirs with their accompanying extra costs. Capital costs for relocation and upgrading are estimated at $2,885,000 and $9,240,000 for the Alameda and Rafferty sites respectively. Increased annual operation and maintenance costs are estimated at $29,000 and $92,000 respectively.

Several aboriginal campsites will be inundated by reservoir waters. These sites are being evaluated to determine the archaeological value of each. The most promising sites will be excavated before valley inundation. The sites appear to be typical of those commonly found in Saskatchewan. Funds have been made available to complete the archaeological work immediately. In general, funds are continually available for some exploration and the impact of the proposed reservoirs are to make monies available sooner than would normally occur. The more promising sites would eventually have been studied, with or without this proposed project. $1.3 million has been allocated for all archaeological work required on the project.

.5 Dam and Reservoir Construction

Dam construction costs including engineering are estimated at $31,295,000 and $26,350,000 for the Alameda and Rafferty Dams respectively. Annual operations and maintenance costs are estimated at $107,600 and $156,600 respectively.

Both reservoirs, and, in particular, the Rafferty reservoir, will be surrounded by extensive grazing lands. Livestock use the river and creek as well as dugouts for water supply. The reservoirs areas will be fenced to ensure reservoir bank stability, maintain water quality, and livestock safety. Additional stock watering ponds will be developed as alternate stock water sources. The dugouts will be strategically situated to ensure increased utilization of the grazing lands. The capital costs for the fencing and dugout programs are estimated at $100,000 and $400,000 respectively on the Alameda and Rafferty reservoirs. Annual costs are estimated at $10,000 and $40,000 respectively.

Recent exploration of the proposed reservoir sites have identified some major gravel deposits. Current estimates of the amount of economically recoverable gravel deposits in the reservoirs indicate that, dam construction will likely require all the available material.

The reservoirs are considered multi-use reservoirs where water quality is an important factor. The valley must be cleared of larger organic materials such as shrubs, trees and buildings to alleviate extensive decay and loss of oxygen in the reservoirs. Also water logged debris is a serious danger to boaters. Preliminary estimates suggest valley clearing costs of $100,000 and $300,000 for the Alameda-Rafferty reservoirs respectively.

.6 Capital Costs Summary

A summary of capital costs to be incurred by the provincial government for construction of the reservoirs, including mitigation costs for adverse reservoir impacts plus some enhancement costs for recreation, fish and wildlife opportunities are outlined in Table 12. Total capital costs to be incurred by the Saskatchewan government for the development of both reservoirs are estimated to be $126,000,000. excluding the anticipated U.S. contribution. Additional costs to the Saskatchewan government not included in Table 12 include an estimated $4,000,000. in administration costs to study and oversee the project. Additional costs to be borne by other sectors of society include irrigation system and on-farm capital costs for irrigation development. See agricultural appendix for detailed irrigation development costs. Also additional capital of $10,175,000. will be required by private developers and individual cottage owners for cottage development around the reservoirs.

Table 12: Capital Costs to be Incurred by the Saskatchewan Government for Alameda Rafferty Project ($000)

	Alameda	Rafferty
Agriculture		
Land lost and social disruptions	4,310	6,600
Recreation		
Dr. Mainprize relocation and enhancement		1,720
Recreation sites development	1,200	2,690
Fish and wildlife enhancement		1,140
Water Supply	60	365
Other		
Oil well mitigation	4,055	18,165
Power line relocations	600	300
Transportation	2,885	9,240
Bible camp mitigation	--	--
Heritage resource mitigation	520	780
Dam		
Dam construction	31,295	26,350
Diversion channel	--	9,525
Fencing and dugouts	100	400
Reservoir valley clearing	100	300
Sub Totals	45,125	80,875
Grand Total (1986 Dollars)		126,000

6.4 Benefit Cost Analysis

.1 Forward Linkages

Reservoir development will create both social and economic opportunities. Direct impacts are those opportunities to utilize irrigation to increase agricultural output, for the public to participate in water-based recreational activities, for power companies to produce electricity more efficiently, and to protect river valley property from flood damage. The existence of these activities provide the necessary base for additional activities to be developed. Activities such as livestock development in neighbouring areas based on forages from the irrigated land base, processing agricultural products from irrigated agricultural products, developing restaurants and motels to accommodate the increased traffic flows, and increased industrial activities from less expensive electricity are examples of forward linkages from the direct beneficiaries of a project. The extent of opportunities for forward developments form a significant component of the opportunities arising from a project.

The forward linkages to livestock processing were the only forward benefits assumed for this study. The local area aalready has extensive livestock populations and it is expected that the majority of forages grown on the irrigation base are an integral part of the irrigated farm unit and are utilized on the irrigated farm, rather than shipped to other livestock producers.

Livestock processing is atypical of agricultural processing with a high proportion of production costs required for labor.

.2 Backward Linkages

Purchases by the primary beneficiaries, by the forward beneficiaries and for the project development itself are made from the provincial and national economies. A purchase by one economic entity is a sale for another economic sector. As each sector increases production activities to meet increased sales, the impact of its production oriented purchases are trickled back through its suppliers until virtually all sectors of society are affected. The issue of measuring backward linkages is continually being questioned as all purchases have backward impacts through the economic community. However, the type of purchases incurred by the direct beneficiary does affect the magnitude of the backward linkages. For example, the agricultural processing sector is highly labor intensive, as well as the service sector, which is a major component of the recreationists' purchases. The backward linkages from these activities will have far greater backward impacts through the economy than the purchase of an air cooled power generating plant, where much of the machinery plus the air-cooled technologists will be imported. In light of the above, net present value and benefit/cost ratio formulations have been developed to include backward linkages.

.3 Benefit/Cost Analysis

Benefit/cost ratios have been formulated as follows:

Direct B/C = Direct Benefits/Project Costs

Direct benefits include agricultural returns, recreational benefits, power generating savings, U.S. and Saskatchewan flood control, as outlined in Section 6.2.4 and 6.2.5. Project costs include those costs as outlined in Section 6.3. Costs are agricultural on-farm irrigation and farm equipment investment, lost agricultural land and social costs of disruption. Irrigation system development and operation is considered an agricultural cost. Recreation costs are recreation site mitigation, enhancement and development, plus the increased annual costs associated with these developments. Recreation costs also include cottage development, wildlife enhancement, and fishery development, plus annual costs. Municipal water supply system mitigation, including a contingency fund for rural water mitigation, are considered project costs. Other project costs include oil well mitigation, power line relocation, and grid road mitigation. Dam construction and operations, including the opportunity cost of money to stockpile gravel before it is demanded, and project administration fees are included in direct project costs.

Net present values (NPV) have been included as an alternate economic indicator. This measure of economic viability is preferred by many analysts because the measure includes the magnitude of the economic impact arising from a proposed project. This indicator is derived by subtracting all discounted costs associated with the project from all discounted project benefits.

Projects incur costs and provide benefits over a period of time. Typically, costs such as construction costs are incurred at the start of a project and may taper off over time to the level of maintenance costs. Benefits may not begin to accrue until construction is complete and may continue to be enjoyed for many years.

In a world where households, firms, and governments are prepared to pay a premium to have money today, as opposed to some point in the future, it is reasonable to weight (discount) future benefits and costs somewhat less than those values would be weighted today. Thus, the further in the future the benefit or cost is experienced, the greater its contribution to PVS is discounted. The choice of the discount rate is crucial to the economic feasibility of the project. Generally, for water resource projects, the higher the discount rate, the less attractive the project. This is due to the fact that the benefits accrue further off in the future than the costs and are discounted more heavily.

Direct returns to the project are slightly less than unity - Table 13.

Table 13: Direct Benefits and Costs

Discount rate	5%	5%	10%	10%
Agricultural Scenario	Grain	Livestock	Grain	Livestock
Direct benefits	213,676	242,110	134,539	147,962
Direct costs	213,950	238,182	155,102	166,426
Direct NPV	-274	+ 3,928	-20,563	-18,464
Benefit/Cost ratio	0.999	1.016	.867	.889

Direct benefits and costs represent the sum of the benefit cost capital and annual expenditures discounted to a present value. The time series assumed for each benefit cost series is shown in Benefit Cost Appendix.

The indirect benefit/cost ratio includes those benefits included in the direct benefit/cost ratio plus the backward linkages arising from the expenditures of the following activities: agriculture on farm and irrigation system development, recreation visitor day expenditures, recreational site removal and redevelopment, cottage development, wildlife enhancement and fishery development, rural water mitigation, Hitchcock community water intake facilities, oil well mitigation, power line and phone line relocation, road mitigation, and administration fees. Backward linkages from dam construction, fencing, and reservoir clearing were also included. Backward linkages from land lost to agriculture and from increased power generating efficiencies were deducted from total direct benefits. The indirect benefit/cost ratios have been formulated as follows:

$$\text{Indirect B/C} = \frac{\text{Direct benefits + Backward linkages}}{\text{Project Costs}}$$

Indirect benefit/cost ratios are greater than unity (Table 14). These ratios, typical of water development projects, indicate the far reaching impacts of water resource development to the rest of the economy.

Table 14: Total Indirect Benefits and Costs

Discount rate Agricultural Scenario	5% Grain	5% Livestock	10% Grain	10% Livestock
Indirect benefits	153,950	169,192	93,269	100,363
NPV (direct and indirect)	153,676	173,190	72,706	81,899
B/C	1.718	1.727	1.469	1.492

A significant strength for water resource development is through the development of forward linkages. Because of the smaller size of the proposed irrigation development, compared to the larger developments around Lake Diefenbaker and in Alberta, and because of the relatively remote location from large urban populations, the opportunity for forward linkages is not as extensive as other regions. Only livestock processing was identified as a significant potential forward linkage. Table 15 demonstrates the additional impact of including forward linkages only with the direct benefit cost ratio.

Table 15: Direct plus Forward Linkages (Livestock plus)

Discount rate Agricultural Scenario	5% Livestock	10% Livestock
Forward Linkages	3,371	1,860
NPV (Direct & Forward)	7,299	-16,604
B/C	1.031	0.900
B/C (Direct & Forward & Backward Linkages)	1.741	1.503

The benefit/cost ratio (Direct + Forward + Backward) includes all benefits estimated for the Alameda-Rafferty project. This ratio represents the total impact that will be felt through the economy from all direct beneficiaries, from their expenditures from the opportunity to invest in a livestock processing industry and the livestock processing industry's purchases.

Much debate has centered on the appropriateness of various benefit/cost ratio configurations. The demonstration of several ratio formulations is intended to demonstrate the potential impacts on the economy in a format comparable to other public investment alternatives. Any given ratio demonstrated above is not the sole criteria to evaluate the potential of the Alameda-Rafferty project, but a spectrum of ratios allows a more thorough evaluation of the project's potential economic impacts. (See Benefit Cost Appendix for more detail on alternate formulations of benefit/cost ratios.)

7.0 SUMMARY AND CONCLUSIONS

7.1 Summary

Water is a scarce resource in the Saskatchewan portion of the Souris Basin. Consequently, proper management of this resource is a high priority. Surface water area per total basin area is the most dramatic comparison of water scarcity in the Souris Basin with a ratio of .002, compared to a high ratio of .064 for the Saskatchewan River Basin. In other words, water in the Saskatchewan River Basin is 32 times more plentiful. The U.S.A. appears to be more water management conscious than Saskatchewan as is illustrated by a scarcity ratio of .005 in the Souris Basin in North Dakota which is 2.5 times more water surface area than in the Saskatchewan portion of the Basin.

The direct beneficiaries of the proposed Alameda-Rafferty projects are agriculture with a potential of 12,000 acres of irrigation development, recreation with a potential increase of 332,000 visitor days for the Rafferty-Alameda areas, water cooling potential for one of the 300 mW power units at the Shand power generating station, and increased flood control for the valleys below the reservoirs.

Costs, in turn, include the lost agricultural potential of 15,200 acres of mixed grass and cultivated lands, disruption in lifestyles and household incomes, particularly for those within the reservoir area, the loss of critical habitat for whitetail deer and the loss of a community park site, which stands as a testimony to community spirit and service. Dr. Mainprize Park, however, will be reconstructed at a new site on the reservoir. Other costs are financial costs borne by the public at large. The direct benefit/cost ratios for the Alameda-Rafferty projects are 1.02 at a 5% discount rate, assuming extensive livestock development on the irrigated land base, and .89 at a 10% discount rate. A benefit cost ratio of less than unity indicates that quantified costs exceed quantified benefits. Costs of resource development projects often exceed local benefits derived thereof, but the projects often receive continued public support because of the potential spinoff.

For example, total benefit/cost ratios, including all forward and all backward linkages, are 1.78 and 1.55 for 5% and 10% discount rates respectively, assuming a livestock oriented irrigated agriculture. This potential for total societal gains has been used for justification of previous projects.

7.2 Conclusions

The quantified benefits and costs indicate a direct benefit/cost ratio of slightly less than unity. Other issues such as indirect benefits beyond the project and non-quantified issues such as the relative scarcity of water in the basin, combined with the desire to develop local aesthetics, community pride, community stability and local economic development opportunities continue to press for continued water development opportunities such as the Rafferty-Alameda project.

APPENDIX ONE

WATER SCARCITY

INTRODUCTION

The relative value of a commodity is reflective of its abundance or scarcity and its ability to produce utility or well-being to a nation. Although it is critical to life, people often have considered air of little value because of its relative abundance. The air pollution arising from industrialization has changed clean air to a much rarer commodity with an increased value. People are now willing to invest large amounts of capital to ensure themselves adequate quantities of clean air.

The value of water follows the same logic as that of air. Water is vital to life, but abundant supplies throughout much of Canada has created a public attitude of a minor valued commodity. Consequently, if the evaluation of one water resource project does not indicate high returns to society, it is a relatively easy decision to discount that particular project in favor of another project with higher returns and utilizing another relatively inexpensive water source.

Unfortunately, not all regions have abundant water resources. In these areas, water becomes a valued resource, with more public pressure to manage it more intensively and wisely. Where a water development project with marginal returns is set aside in a region of abundant water, much more caution must be used in the evaluation of projects in areas of scarce water supplies.

The Souris Basin is an area of limited water which reflects a relatively high value for water development. Groundwater in the region is abundant, but its poor quality requires extensive treatment for domestic and industrial uses. Surface water is available through the Souris River and its tributaries. As its name implies, very little water is available during most of the year. This minimal flow allows for some municipal, industrial and agricultural withdrawals, but because of the limited flows through the summer months, water quality is marginal. Virtually no water is available for quality recreation. On the other hand, after heavy snowfall, spring runoffs turn the Mouse into a raging lion. With no facilities to capture these spring flows, within a matter of weeks water supplies are again limited to relatively minor flows.

The United States, in North Dakota, have responded to these dramatic seasonal fluctuations by developing two significant fish and wildlife enhancement projects. (The J. Clark Salyer Refuge and the Lake Darling Reservoir). These projects have utilized the river valley terrain to its maximum potential to store and manage water. Because of the high value of water in this region and because of the large fluctuations in river flows, the U.S. Army Corps of Engineers is willing to participate with Saskatchewan in developing the Alameda and Rafferty dams as the next logical step in a comprehensive management program.

The purpose of this study component is to estimate the degree of water scarcity that exists within the Souris Basin. This will be accomplished by identifying components of a water scarcity measure, then comparing the scarcity index components across several river basins in Saskatchewan. If water is relatively scarce in the Souris basin, then a case can be made for more intensive water management programs within the Souris basin, than can be justified in the more water abundant regions.

The format of this appendix is an introduction of Saskatchewan's water basins, an introduction of water scarcity components, a comparison of these components across several river basins and conclusions.

SASKATCHEWAN DRAINAGE BASINS

Saskatchewan has been divided into fourteen drainage basins (Figure 1). Some basins drain via relatively minor tributaries into Lakes and are labelled by the Lake into which they drain. The basins which drain into more prominent rivers are labelled by that river. The basins are as follows: Souris, Missouri, Cypress Hills, Old Wives Lake, Qu'Appelle, South Saskatchewan, North Saskatchewan, Saskatchewan, Churchill, Athabasca, Tazin, Kasba, Assiniboine, and Lake Winnipeg.

Only those basins which drain into a prominent river were selected as a basis of comparison to the Souris. Data for the Athabasca, Churchill, Tazin, and Kasba river basins were combined into one category, Northern, as these regions are relatively homogeneous in comparison to the Souris. Data was not complete for the Missouri basin and it is included as an additional data point. It is expected that this basin is equal to and in some instances exceeds the Souris basin's scarcity measures.

In addition, available data from three southern Alberta river basins; the Bow, Oldman and Red Deer, were included as additional points of reference along with the Souris River in the United States. In the case of the latter, data was supplied by the North Dakota State Water Commission.

SCARCITY INDEX COMPONENTS

Crop Water Deficit

Precipitation is often inadequate to meet all potential crop water requirements. As surface stream flows are used to supplement this deficit, those areas with higher deficits can be expected to place a higher value on available surface flows. Basin water deficits are seasonal water deficits at 50% probability, May through September, 1931 to 1960. Base assumptions are 25 mm of storage and a consumptive use factor of 1.0. The source is the Agroclimatic Atlas of Canada, Agriculture Canada, Figure 1.3.

River basins in general, stretch from higher elevations in the west, with more precipitation, to lower elevations and less precipitation, in the east. The variability in crop water deficits across a basin generally varies more than the deficits across basins. If irrigation has been developed, the deficit data appropriate to the major irrigated areas within the basin were chosen, otherwise a midpoint across the basin was chosen.

Basin Water Yield

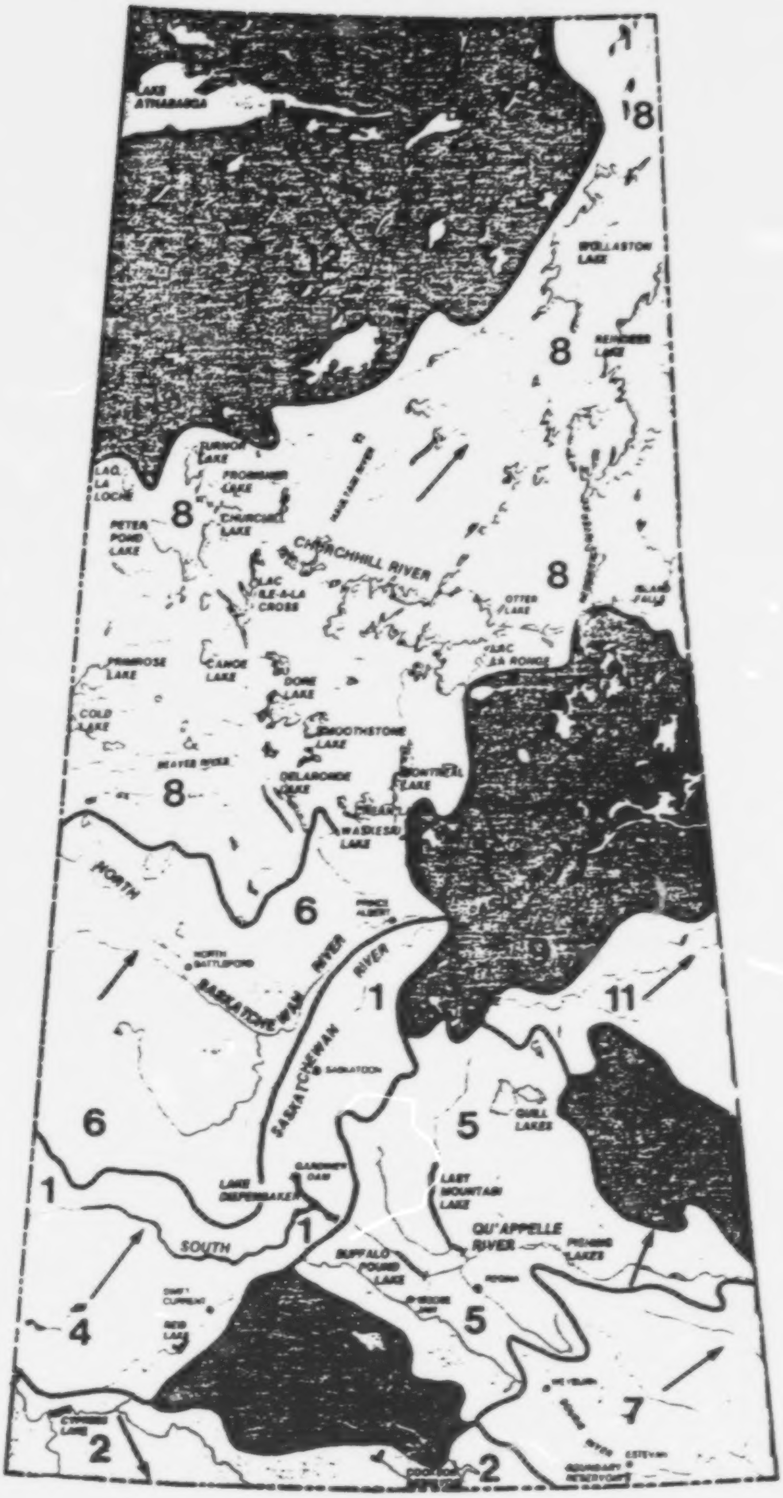
Basin water yield is a property of the watershed referring to the quantity of water available from a stream at a given point over a specified duration of time. It is a summation of the continuous hydrograph of flow at a particular point on a stream. It is, therefore, the consequence of all hydraulic events resulting in flow, including storms of all durations and intensities, and the climatic, geologic and land use environment.

The emphasis is on water volume rather than instantaneous rates.

FIGURE 1

MAJOR DRAINAGE BASINS

1. SOUTH SASKATCHEWAN RIVER
2. MISSOURI RIVER
3. OLD WIVES LAKE
4. CYPRESS HILLS NORTH
5. QU'APPELLE RIVER
6. NORTH SASKATCHEWAN RIVER
7. SOURIS RIVER
8. CHURCHILL RIVER
9. SASKATCHEWAN RIVER
10. ASSINIBOINE RIVER
11. LAKE WINNIPEGOSIS
12. LAKE ATHABASKA


LAKE ATHABASCA
12
8
WOLLASTON LAKE
REINDEER LAKE
8
LAC LA LOCHE
TURNOR LAKE
FROBISHER LAKE
CHURCHILL LAKE
PETER POND LAKE
8
CHURCHILL RIVER
LAC ILE-A-LA CROSSE
8
OTTER LAKE
ISLAND FALLS
LAC LA RONGE
PRIMROSE LAKE
CANOE LAKE
DORE LAKE
COLD LAKE
SMOOTHSTONE LAKE
BEAVER RIVER
DELARONDE LAKE
MONTREAL LAKE
8
WASKESIU LAKE
NORTH
6
PRINCE ALBERT
NORTH BATTLEFORD
SASKATCHEWAN RIVER
RIVER
1
9
11
SASKATCHEWAN
SASKATOON
6
5
QUILL LAKES
1
LAKE DIEFENBAKER
GARDINER DAM
LAST MOUNTAIN LAKE
1
SOUTH
QU'APPELLE RIVER
PICKING LAKES
BUFFALO POUND LAKE
REGINA
4
RED LAKE
3
5
7
CYPRESS LAKE
2
2
ESTEVAN
BOUNDARY RESERVOIR

LEGEND

- RESERVOIR
- DAM
- DIRECTION OF DRAINAGE

Annual total discharges were obtained from various hydrological stations, Canada Environment. River flow data history for the various basins vary from 13 to 70 years.

Water yields have been expressed as a total yield (1000 dam^3 per year) and as a proportion of water yield (dam^3) to total basin area (km^2).

Annual Streamflow Variability

The coefficient of annual streamflow variability is the standard deviation of monthly discharge means divided by the average of monthly discharge means. The basic question answered here is; how much does the river vary as a proportion of its size? As in the case of the Souris, high water yields, of which the majority occurs within a few weeks of the year, is of little value without water management facilities to capture it.

Average Minimum Flows

Minimum flows for each basin have been recorded as nil for the Qu'Appelle, Assiniboine and Souris rivers. Average minimum daily discharge over the period of records was chosen as a more representative measurement of the low seasonal flows expected every year. This measurement is intended to add another dimension to basin hydrological characteristics.

Water Surface Area

Water based recreation, such as boating and fishing, are highly dependent on the available surface area of water. Water surfaces of the lakes and rivers in each of the basins were measured to determine water and basin areas. The majority of data was obtained from 1 to 50,000, National Topographic Series maps and 1 to 250,000 maps for the larger lake areas. "Land Use in Saskatchewan" (Rump, 1980,) and Fisheries Lab, Saskatchewan Parks and Renewable Resources, were consulted for additional detail. All bodies of water 300 hectares and greater were measured, plus smaller lakes, if they had been identified by the Prairie Provinces Water Board, Saskatchewan Nelson River Basin Study, as having significant recreational developments.

Water surface area is measured by square kilometers. A relative measure of water surface area to total basin area (km^2/km^2) adds a further dimension to the availability of water and the potential aesthetic qualities from lakes and rivers.

Basin Population

This and the following index components are not direct measures of the availability of water. However, demographic observations such as population densities, can be, in part, the result of the availability of water resources. (See Socioeconomic Section of E.I.S. Rafferty/Alameda Projects, 1987).

Also areas with larger populations tend to require more extensive capital investment and management of the regions' resources. Higher population densities would, in turn, suggest a greater awareness and higher values placed on water resources. Consequently opportunities for water development in areas of lower population densities, such as the Souris basin, may not be fully recognized.

Basin populations were estimated by correlating population numbers by addresses from 1984 Saskatchewan Hospital Services Plan data. Populations with addresses covering more than one basin were prorated across the basin. Alberta population numbers were based on 1984 Statistics Canada data by census division. Census division populations were prorated over the respective Alberta basins, and consequently the Alberta population data is not as precise as basin population estimates for Saskatchewan.

Populations are stated by total population per basin (000) and by person per square kilometer of basin area.

Population Dynamics

The interaction of demographics and water resource development is discussed in the Quality of Life appendix and in the more general Environmental Impact Statement of which this study is a component. Issues of concern include: can the lack of public investments and social amenities associated with water resource development be associated with population declines? Reliable water supplies are a component of industrial and agricultural development potential which, in turn, lead to population growth.

The population declines are rural basin populations relative to general rural population movements in Saskatchewan. The data addresses the questions: did rural population declines in the basin decline as fast or faster than the provincial populations. (See Socioeconomic Section of E.I.S. Rafferty/Alameda Projects, 1987).

Population declines are expressed as percent of provincial decline. If the basin lost 110 people for every 100 people lost to rural areas in the province, the index for the basin would be 110 or the basin declined 10 percent faster than the general rural population decline. Population dynamics were calculated over the periods of 1951 to 1984 and over the periods of 1961 to 1984.

Number of Water Based Recreation Sites

The Souris basin is not at present considered by many residents to be the focus of major water oriented recreation opportunities. The Moose Mountain Creek area provides excellent opportunities, but the area is small and over-utilized. Some cottages are located on Boundary Reservoir, but extensive coal mining and the Boundary Dam Power Station close by, create a limit to the panoramic amenities enjoyed at the Boundary Reservoir site.

The number of existing water based recreation sites does not account for the qualitative component of the facilities nor does it account for the people pressure on the facilities from outside of the basin area.

The number of recreation sites is based on a count of sites regardless of quality or size. An additional measure of sites per basin population is an indication of local population pressures on the recreation facilities. Number of campsites per population is included as a measure of recreation site sizes.

COMPARISON OF INDEX COMPONENTS ACROSS BASINS

Crop water deficits in the Souris basin are approximately 225 mm per year. (Table 1) The greatest crop deficit is in the Missouri basin at 350 mm per year. Crop water deficits in the majority of agricultural cultivated areas are approximately 175 mm per year. The Souris basin is one of the higher crop deficit areas in the province except for the southwest portions of the province which are extremely dry.

Water yields for the Souris basin appear low, compared to basin yields per basin area for the other basins. Annual variability of yields indicates major fluctuations in an already low yield for Souris compared to the other basins. The Souris river, and its sister river the Assiniboine, demonstrate the characteristic flows of prairie rivers with low flows and, at times, no flows. The Souris and the Assiniboine demonstrate the greatest variability in flows relative to their size and the average lowest flows recorded through the season.

In absolute water area, the Souris basin is woefully lacking, with 65 km^2 of water surface area. This is compared to the next lowest basin, the Assiniboine, with 252 km^2 of water area. If the proportion of water surface area to total basin area is considered, the dearth of water becomes even more apparent with two thousandths of the land area in the Souris covered with water compared to the next lowest of fifteen thousandths in the Assiniboine basin and the highest proportion in the Saskatchewan basin with sixty-four thousandths of the total area.

TABLE 1. SCARCITY INDEX COMPONENTS BY RIVER BASIN

	CROP WATER DEFICIT/ YEAR(mm)	ANNUAL WATER YIELD (1000 dam3)	WATER YIELD/ BASIN AREA (dam3/km2)	ANNUAL STREAMFLOW VARIABILITY *	AVERAGE MINIMUM FLOW (m3/s)	WATER SURFACE AREA (km2)	WATER SURFACE AREA/BASIN AREA	1984 BASIN POPULATION (1000'S)	BASIN POPULATION DENSITY (person/km2)	BASIN AREA (1000 km2)	DECLINE INDEX FOR RURAL POPULATION % OF PROVINCIAL DECLINE 1951-84	1961-84	# OF WATER BASED PARK SITES	# OF WATER BASED PARK SITES/1000 POPULATION	# OF CAMPSITES/ 1000 POPULATION
SOURIS (Sask)	225	127	4.29	1.65	0.07	65	0.002	63.2	2.14	29.6	111	112	18	0.28	34.9
SOURIS (USA)	305	230	5.25	1.32	0.40	206	0.005	163.3	3.73	43.8	-	134	96	0.59	-
MISSOURI	350	-	-	-	-	-	-	12.6	0.59	21.4	99	101	3	0.24	44.3
QuAPPELLE	175	309	5.21	0.84	1.3	1175	0.020	321.1	5.41	59.3	109	111	53	0.17	9.2
SOUTH SASKATCHEWAN	300	740	20.50	0.31	51	1163	0.032	245.9	6.81	36.1	109	114	34	0.14	13.9
NORTH SASKATCHEWAN	200	258	4.07	0.76	30.5	1234	0.019	150.8	2.38	63.4	88	88	55	0.36	19.5
SASKATCHEWAN	125	4100	66.99	0.34	221	3927	0.064	34.5	0.89	61.2	93	87	83	1.52	30.7
"NORTHERN"	75	23720	76.84	-	-	-	-	42.8	0.14	308.7	71	77	74	1.73	62.6
ASSINIBOINE	175	166	9.54	1.51	0.05	252	0.014	58.2	3.34	17.4	109	100	19	0.33	14.3
BOW	175	3160	124.90	0.59	19.5	-	-	620.0	24.51	25.3	-	-	-	-	-
OLDMAN	200	2820	165.88	1.10	8.9	-	-	140.0	8.24	17.0	-	-	-	-	-
RED DEER	200	1870	41.83	0.81	4.3	-	-	180.0	4.03	44.7	-	-	-	-	-

* - STANDARD DEVIATION OF MONTHLY DISCHARGES / AVERAGE OF MONTHLY DISCHARGE MEANS

The U.S. investment in water management projects along the Souris in North Dakota show up by comparison with 2.5 times the water to land surface area. Sixty percent of the water surface area in the Souris basin in North Dakota is attributable to artificial impoundments.

Population density per km^2 indicates a moderate population density of 2.14 people per square kilometer. Declines in rural population indicates a larger proportionate decrease of rural populations in the Souris basin to all other rural basins. People are migrating from the rural Souris basin area at a faster rate than any other river basin in Saskatchewan. (See Socioeconomic Section of E.I.S.).

In regards to water based park sites per population, three river basins have fewer parks per local population than the Souris basin. Again, the Souris basin is a member of the basin group exhibiting the greatest lack of water related amenities. All of the above groups are located in the southern part of the province. These southern basins have some of the largest number of campsites per population. This is because limited water resource potentials cause available sites to be developed to the maximum potential and there is probably a major influx of recreationists from outside of the basin.

Comparison to U.S.A. Developments

The U.S.A. has developed water management facilities along the North Dakota portion of the Souris to the fullest practical limits. For instance the river valley is relatively shallow in the U.S.A. and Lake Darling uses a series of weirs along the valley floor to create a large although shallow reservoir. Yields and variability of yields of the U.S.A. Souris basin are comparable to the Saskatchewan portion and yet measures of water aesthetic opportunities, such as water surface area and water based recreation sites within the basin,indicate a much higher degree of water management awareness on the part of U.S.A. than has been present in Saskatchewan until recently.

CONCLUSIONS

While the Souris basin did not necessarily rank as the highest water scarcity area for all scarcity index components, but with one exception, it was in the group exhibiting the greatest water scarcity. This analysis underscores the fact that water supplies in the Souris basin are indeed limited. The result is a higher local value placed on water resources and a much more urgent mandate to manage these water resources properly. One need only look to the Souris River in the United States to witness what can and is being done within the basin to maximize opportunities with this scarce commodity.

APPENDIX TWO

AGRICULTURAL BENEFITS AND LOSSES

INTRODUCTION

Agriculture is one of the intended beneficiaries of the proposed Rafferty/Alameda projects. The Saskatchewan portion of the Souris River Basin is a semi-arid region, with agricultural opportunities limited by suboptimal rainfall in most years.

Some irrigation is currently occurring in the basin, mostly as a fodder base for livestock operations in the area. Available water for irrigation is limited, as most of the stream flow occurs during the early spring thaw and flows are highly variable between years. The Rafferty and Alameda reservoirs will provide more reliable water supplies during the periods of high irrigation demand which will allow for significant increases in potential irrigated areas.

The objective of this agricultural analysis is to estimate the direct benefits accruing to agriculture from construction of the Rafferty and Alameda reservoirs. Both the impacts of increased irrigation opportunities and the agricultural land base inundated by the reservoirs are to be evaluated.

WRC Engineering has completed an economic analysis of the benefits from the increased irrigation opportunities.[1] The analysis covered several potential irrigation development scenarios and water management scenarios. This study will continue with two potential irrigation development scenarios, but will be limited to one water management scenario. The following water development scenario provided the basis for the Rafferty and Alameda Dams comprehensive benefit-cost analysis.

The Refferty Dam on the Souris River will provide cooling water for one 300 mW thermal power unit at the Shand plant; flood control downstream of Weyburn; irrigation and municipal water supply; and, water based recreation on and adjacent to the reservoir. There will be a flood water diversion channel from Boundary Dam to the Rafferty

Reservoir. The Dam will be built at Site "C" with a fully supply level of 550.5 m and a flood surcharge level of 554.0 m. In order to reduce the impact of Rafferty, on oil field operations, the reservoir will be operated with a temporary FSL of 549.5 m until such time that the oil reserves will be depleted (currently estimated at 20-30 years). After such time, the FSL will be permanently raised to the 550.5 m level.

The Alameda Dam on Moose Mountain Creek will provide flood control storage, irrigation water supply, water based recreation on and adjacent to the reservoir; and, international flow commitments. The multipurpose full supply level of the reservoir will be 574.0 m and the flood surcharge level will be 579.0 m. The United States will credit Saskatchewan's international flow commitment with 50% of the net reservoir evaporation from both Rafferty and Alameda reservoirs.

The impact of increased irrigation from the expanded water supply will be taken directly from the WRC report. Estimated agricultural land resources to be inundated by the reservoirs are presented in a draft report completed for the Souris Basin Development Authority and Saskatchewan Power Corporation.[2] The inundated areas, as reported in the above report, will serve as a basis to evaluate the total impacts of agricultural land lost to the reservoirs.

BACKGROUND

Topography

The Souris River is essentially a prairie river within a relatively narrow and shallow river valley. Only limited portions of the land within the valley is cultivatable and suitable for irrigation. Much of the irrigated land upstream of Estevan is utilized as a livestock forage base. The land on either side of the river valley upstream of Estevan is marginal agricultural land for up to one to two miles from the valley, and is extensively used as a grazing land base.

Downstream of Estevan, the land is of higher quality with cereal crop land approaching the river valley slopes, and much of the river valley is an extension of the upper level cereal production land.

The valley associated with Moose Mountain Creek is more shallow. The surrounding land at the proposed Alameda site is good quality productive cereal land with moisture being the only limitation to crop yields. Cultivated cereal acreages often extend over the river valley slopes and approach the creek.

Lands surrounding the Rafferty Reservoir (Rafferty uplands) are generally of marginal quality. Irrigability indices indicate the land has fair to poor potential for irrigation development. The land surrounding the Alameda Reservoir (Alameda uplands) on the other hand has good to poor potential for irrigation development. The bottom lands downstream of the reservoirs indicate the most favorable potential with good to fair potential. Although bottom lands are limited in size and irregularly shaped because of topography and meandering of the river, they require low pump lifts from the stream to the irrigable land and are thus less capital intensive.

Table 2. Suitability of land for irrigation development around the proposed Rafferty and Alameda Reservoirs

	Rafferty Reservoir (Uplands)	Alameda Reservoir (Uplands)	Bottomlands Downstream From Reservoirs
Class 1		1,788 (1.3%)	
Class 2	45,212 (7.9%)	75,784 (54.9%)	9,503 (54.8%)
Class 3	270,294 (47.1%)	21,757 (15.8%)	6,336 (36.5%)
Class 4	258,588 (45.0%)	38,596 (28.0%)	1,501 (8.7%)
	574,094	137,925	17,340

The four classes are described as excellent (Class 1), good (Class 2), fair (Class 3) and poor (Class 4). A brief description of these classes is presented below:

Class	Rating	Description
Class 1	Excellent	Lands in this class have no significant limitations for irrigation. The soils are medium textured, well drained, and hold adequate available moisture. Harmful accumulations of soluble salts are absent from the soil and topography is often level or nearly level.
Class 2	Good	Lands in this class have slight limitations for irrigation due to unfavorable characteristics of either the soil or landscape or both. The soils in these classes may be heavier or lighter in texture than soils in Class 1.

Class 3	Fair	Lands in this class have moderate limitations for irrigation use due to deficient characteristics of either the soil, the landscape, or a combination of both. The soils may be inferior because of excess salinity, sodicity, very low hydraulic conductivity or low water holding capacity. Greater management input, as well as more intensive soil conservation and improvement practices, are required for this group of soils than for the soils in the good category.
Class 4	Poor	Lands in this class have severe limitations for irrigation use due to adverse characteristics related to either the soil, the landscape or a combination of both. These lands may have some limited use under irrigation, but generally their limitations are so severe that they do not form suitable irrigation-farm units.

Climate and Crop Water Requirements

The mean annual frostfree period is 90 to 110 days, and the growing season is about 175 days. Total precipitation varies from 380 mm in the southern part of the basin to 455 mm on the higher elevations in the Moose Mountain Creek area. About 60% of the annual precipitation occurs from May through September. The mean July temperature is in the 18 degree Celsius range.[3]

Total consumptive use is estimated at 550 mm for an assumed cereal forage crop mix. Upland irrigation water requirements were estimated as follows:[4]

	Crop Requirement + (mm)	Less Effective Precipitation & Soil Reserve (mm)	Irrigation = Requirement (mm)
Avg. Yr. Requirement	550	290	260
Peak Yr. Requirement	550	240	310

In addition to direct irrigation demand, additional water is required for system losses and on-farm losses. These include operations waste (extra water required to balance irrigators' demands within open canal systems), losses due to emergency shutdowns, and spring and fall startup/shutdown system losses apply only to the larger upland cooperative developments. On-farm losses include evaporation, wind drift and surface runoff. Extra water periodically applied to the soil to leach salts, etc. down out of the root zone is also required as an essential component of irrigation management. In all, for the uplands, the additional water required is one and one half times that required directly by the plant.

Water uses for a peak year are estimated as follows:

Water Requirement	Upland mm	River Valley (Lowland) mm
Irrigation demand	310	260
Operational Waste	10	0
On-farm Losses	100	30
Leaching	30	10
TOTAL	450	300

The above water requirements correspond with current Saskatchewan Water Corporation irrigation water licensing policy.

Water Supply

There are several potential alternative uses for the reservoir water. These uses are often in competition with each other, and the benefits accruing to one use are inversely related to the benefits accruing to the other uses. Potential uses are flood control, irrigation, cooling for thermal power generation, municipal water supply, recreation and international apportionment commitments. The water supply and allocation is as follows:

- Both Rafferty and Alameda Reservoirs are developed
- One power unit for the Shand Thermal plant is cooled from Rafferty Reservoir
- Alameda Reservoir supplies the majority of the international commitment
- Rafferty and Alameda used for irrigation.

Irrigable Acreages

Hydrology profiles were modelled by PFRA to estimate minimum and average basin yields, and water supplies available for the various alternate uses.

Total water commitment can be met on the total irrigable acreage every year or a less stringent operating parameter such as guaranteed water for at least 70% of demand will allow significant increases in irrigable acreages. If water is allocated such that 70% of irrigation water is available in some years, more than six times the 100% acreage can be irrigated. This is consistant with Sask Water Corporation design guidelines for water supply to individual irrigators. This is also consistent with stated supply policy in Alberta as recommended by the Environment Council of Alberta.[17] It was determined that water shortages could be endured without serious agricultural hardship if water shortages of no greater than 90% of demand occured less than one year in ten and the frequency of occurance of two consecutive years with water shortages greater than 80% of demand was less than one year in forty. In short, they state that water shortages in excess of 75% of demand in any given year are to be avoided. The latter figure of a 75% of demand commitment was utilized by the Alberta South Saskatchewan River Basin Planning Program.[18] Current hydrology profiles suggest that 8,000 acres can be developed in the river valleys downstream of the reservoirs and 4,000 acres can be developed on elevations surrounding the Alameda Reservoir.

Agricultural Scenarios

Benefits accruing to agriculture and to society, through the various agricultural activities, depends on the potential change in agricultural activities brought about by the creation of the reservoirs. The change in agricultural activities will, in turn, create a change in the type of agricultural inputs required, and in the potential opportunities for processing agricultural products. It is obvious that extensive agricultural processing and intensive farm activities will not be developed immediately upon completion of the reservoirs. On the other hand, it is unrealistic to expect that irrigation development and its accompanying economic infrastructure will remain relatively undeveloped throughout the life of the project. In order to reflect the various opportunities for growth in the irrigation infrastructure, two economic development scenarios were considered and assessed.

Three hypothetical farm types were formulated as a basis for analysing these development scenarios. The hypothetical farms, identified by their primary enterprise, are outlined below.

- Grain farm consists of 640 developed acres with primary crops being cereals and oilseeds.
- Livestock farm consists of 480 acres with a 100-head cow-calf operation and a feedlot
- Specialty farm consists of 480 acres with potatoes as the principle crop.

The various financial activities of these farm types were simulated over a 15-year period via University of Saskatchewan farm management simulation models. Growth in net worth, farm receipts and expenses were monitored for the 15-year period. Prices and yields were determined by estimating the midpoint in price and yield fluctuations. These midpoints were used as the "base case" for calculating farm benefits.

Base Case Yields and Prices

	Yield	Price
Soft Wheat bu	76	$ 4.90
Barley bu	87	2.60
Canola bu	39	7.50
Alfalfa ton	3.95	87.00
Slaughter Beef cwt		79.00

The grain scenario assumed irrigation development similar to that as exists in the South Saskatchewan River Irrigation District (Outlook) today. The scenario reflects relatively high proportions of cropland devoted to cereals and oilseeds, with relatively minimal numbers of livestock and specialty crop farms.

This scenario was developed by combining the three farm types, as described above, in the proportion of 2 livestock farms, 10 irrigated grain farms, and 4 specialty crop farms. These proportions were developed to reflect a cross-section of farms that could be expected in a grain oriented agricultural economy.

The livestock scenario assumes development of the potential irrigated area similar to that of the four major irrigated areas in Alberta, where livestock oriented farms form a major component of the land base. The three hypothetical farms were combined in the proportion of 16 livestock farms, 4 grain farms and 0 speciality farms to reflect land use and farm mixes as typical of a livestock oriented region.

The lowland scenario was developed to more closely reflect the current agricultural base in the Souris River Basin area. While the other two scenarios are generalized developments for large block irrigation development schemes, the lowland scenario will probably reflect the initial stages of irrigation development in the basin. The scenario was developed by combining two farms in the proportion of two grain farms to one livestock farm.

The two development scenarios (lowland always applies to river valley development and therefore there are only two options) reflect land use patterns as follows:

Table 3: Land Use Patterns for Assumed Scenarios

	Upland Grain	Upland Livestock	Lowland
Forages and Pasture	14	27	28
Wheat	53	36	45
Other Cereals	9	24	5
Oilseeds	14	5	14
Specialty & Vegetable	6	6	0
Summer fallow	4	2	8
TOTAL	100%	100%	100%

Yields

Irrigated acreages can be increased significantly by reducing the reliability of water supplies but the extended acreages are not without costs. Water shortages will marginally reduce crop yields and profits on individual acreages, while the overall production and profit output over the region will increase because of the expanded acreage.

The WRC report assumed an average of 88% reduction in level of production per acre per year for the less-than-firm annual draft. In actuality in 13% of the years, this reduction would be extreme at less than 50% of expected yields.

It is expected that the farmer would be aware of a pending water shortage each year prior to the planting season and would thus alter his variable inputs to compensate for the lack of irrigation water. Compensation for increased forage costs for these "dry" years were accounted for in the WRC agricultural model.

ECONOMIC ANALYSIS

Capital Costs

Capital costs, as demonstrated below, are those costs required to utilize irrigation water once it is available in the reservoirs.

Table 4: Capital Cost Estimates For Irrigation Development

Location	Area (Acres)	Main Pump Station	Irrig. System	On-farm	Total
			($000)		
Alameda Upland	4,000	3,604	4,185	2,798	10,587
Lowland Irrig.	8,000	1,312		5,861	7,173

Main pump stations include the pumping facilities to pump water from the reservoirs to supply the upland areas. For the lowland irrigated areas, the main pump station category refers to the rock weirs constructed in the river to facilitate the pump intakes.

The distribution system delivers water via pressure pipe or canal networks to the irrigated land parcels. The on-farm capital costs include pumping units, if required, mainlines and sprinkler laterals.

On-farm capital costs required to develop irrigation, in addition to irrigation equipment, are as follows:

Table 5: Marginal Cost of Converting an Acre of Dryland into Irrigated Land, by Economic Development Scenario ($/Acre)

Scenario	Farm Machinery	Buildings & Storage	Vehicles	Total
Grain	261.97	73.73	51.40	387.10
Livestock	156.08	66.84	70.11	293.03
Lowland	225.97	71.39	57.76	355.12

Annual Costs and Returns

Annual operations and maintenance costs, excluding on-farm costs for the project, are as follows:

Table 6: Annual Operations and Maintenance Costs (Excludes Cost of On-farm Works)

	Acres of Irrigation	Total Cost ($000)
Block Irrigation		
Alameda Upland	4,000	184.4
Lowland Irrigation	8,000	9.9

On-farm costs and revenues are summarized as follows:

Table 7: Marginal Costs and Revenues from Irrigation Production Under Various Economic Development Scenarios

	Alameda Uplands		
Particulars	Grain Scenario	Livestock Scenario	Lowland Scenario
	($ per acre)		
Cash Input	169.5	414.4	218.0
Hired Labour	19.8	24.0	19.4
Total Cash Exp	189.3	438.4	238.0
Gross Revenue	315.1	595.9	353.6

The next section will address the potential losses from the agricultural resource base to be inundated by the reservoirs.

AGRICULTURAL LOSSES

Agricultural land will be inundated by both the Rafferty and Alameda reservoirs. This land will be permanently lost to society's agricultural base, and thus is included as a cost to the project. Agricultural land losses estimated by air photo interpretation are reported in the Souris Basin Development Authority background studies. Estimated land losses and agricultural categories are shown in Table 8 for Rafferty.

Table 8: Agricultural Losses Within the Proposed Rafferty Temporary FSL (549.5 m)

Agricultural Use	Acres
Grasslands	5,050
Hay land	2,860
Cereal crop production	1,280
TOTAL	9,190

In addition, recreation facilities, gravel pits and farmyards will be inundated. Although not all of the pasture land is currently utilized, it's potential for development in the future has been removed and is thus considered a societal loss in agricultural capacity.

Agricultural lands which will be inundated by Alameda reservoir were also estimated via air photo interpretation and are shown in Table 9.[6]

Table 9: Agricultural Land Losses Within the Proposed Alameda FSL (574 m)

Agricultural Use	Acres
Grasslands	4,224
Hayland	259
Grain	188
TOTAL	4,671

Estimated Agricultural Land Lost Because of Recreational Development Beside the Reservoirs are Shown in Table 10.

Table 10: Agricultural Land Losses for Proposed Recreational Facilities

Proposed Facility	Acres
Dr. Mainprize Golf Course and Marina -	320
Rafferty Recreational Site -	160
Alameda Recreational Site -	160
TOTAL:	640

Farm land parcels and more particularly farm buildings will be severed from the main land base by the reservoirs. Although the severed parcels are no longer a viable component of an individual's holdings, they are not necessarily lost to agriculture, as they may have the potential of being amalgamated with adjacent parcels on the same side of the reservoir. This will result in a certain amount of social adjustment, as some individual holdings become uneconomical, which will result in an early retirement or a reorganization of the farm. These are social costs which generally should not reflect losses in overall agricultural potential although they are included as project costs. Land settlement costs are expected to exceed appraised land values.[7] The increment over appraised land values is a reflection of the social costs incurred by individual land holders and is included in the benefit cost calculations.

Approximately 1,960 acres are currently irrigated in the Souris River Basin area. The majority of this irrigation occurs along the Souris River as very little irrigation is being done in the Moose Mountain area.[8] Approximately 7,414 acres is licensed in the area.[9] If the area under irrigation is limited because of water shortages, the creation of Rafferty and Alameda Reservoirs will allow for irrigation expansion. Some of the actual irrigated acreage and some of the unused licensed irrigation does lie within the reservoir's FSL, in fact, probably most of the hayland to be inundated is irrigated. However, water supply and not a suitable irrigable land base is the limiting factor to irrigation development in the future. It is unrealistic to assume that water management programs can supply water to the point that this limitation is removed. Therefore, creation of the reservoirs relocates irrigable acreages from the areas inundated by the reservoirs to downstream. There are definite social costs associated with this removal, but agricultural production capabilities in general are not reduced. Agricultural production may, in fact, be increased, as the agricultural capability of the land to be inundated in general is inferior to the river valley land downstream of the reservoirs.[10]

Because the reservoirs will not reduce the potential irrigable acreages within the river valleys, the overall agricultural capability lost to the project is non-irrigated land. Assuming all valley hayland is irrigated, only non-irrigated cereal production for both the cereal land and the hayland, and non-irrigated grazing land, will be used as a base for agricultural potential lost by flooding.

Table 11 and Table 12 demonstrate the per acre costs and revenues associated with the land lost to the Rafferty and Alameda reservoirs, and to the recreation sites. Losses will include direct revenues lost to agriculture and the associated secondary benefits (estimated in secondary benefits appendix) which would have continued to occur to the local and provincial economies.

Direct revenue losses are demonstrated in Table 13. In all 14,500 acres will be affected. These losses are the lost returns to the inundated land. Other losses such as lost agricultural wages, opportunities to sell fertilizers etc. are captured in secondary costs. The lost returns to land per year for all future years is $103,500. This is considered a direct cost to reservoir development.

Table 11: Costs and Returns Cereal Production[11]
(per cultivated acre)

Input Costs		
Chemicals	$ 5.40	
Fertilizer	5.80	
Seed	1.45	
TOTAL:		$12.65
Equipment Costs		
Fuel and Lube	6.59	
Equipment R & M	5.56	
Car Expense	0.70	
Custom Work	2.07	
TOTAL:		14.92
Other Cash Costs		
Building R & M	0.66	
Insurance	2.60	
Utilities	1.30	
Taxes	3.13	
Miscellaneous	9.63	
TOTAL:		8.32
Overhead		
Operating Interest	1.29	
Building Depreciation	0.76	
Equipment Depreciation	11.42	
TOTAL:		13.47
TOTAL COSTS:		$49.36
GROSS RETURN[12]		$58.30
NET RETURN TO LAND		$ 8.94

Table 12: Costs and Returns Cow/Calf[13]
(per cow)

Feed		
Hay and Straw	$82.63	
Minerals and Salt	19.70	
TOTAL:		$102.33
Other Cash Costs		
Bull Replacement	63.89	
Vet, Medicine	20.00	
Operations and Repairs	30.71	
Market and Transportation	19.23	
Interest Operating Capital	32.56	
Miscellaneous	18.01	
TOTAL:		184.40
Non-Cash Costs		
Building and Equipment Depreciation	9.89	
Investment Interest	42.00	
TOTAL:		51.89
TOTAL COSTS PER COW:		$338.62
GROSS RECEIPTS PER COW[14]		$405.00
RETURNS TO SUMMER PASTURE		$ 66.38
RETURNS PER ACRE[15]		$ 6.22

Table 13: Direct Agricultural Revenue Losses

	Acres Cultivated	Acres Grazing Land	Total Revenue Loss Per Year[16]
Rafferty	4,140	5,050	$ 68,423.
Alameda	447	4,224	30,269.
Dr. Mainprize	160	160	2,426.
Recreation Sites	160	160	2,426.
TOTAL:			$103,544.

CONCLUSIONS

The Saskatchewan Souris River Basin is a semiarid region with limited water supplies. Seasonal rainfall limits crop growth, and surface water supplies are insufficient for extensive irrigation project development.

The Rafferty and Alameda projects will make available increased surface water supplies for limited irrigation development. Agricultural land lost to reservoir inundation will include grazing land, cultivated cropland and irrigated hayland. The lost agricultural capacity from inundation is more than made up by the potential for irrigation development on the bench lands surrounding the reservoirs and in the river valleys downstream of the reservoirs. The real agricultural costs will be the social adjustments as the economic viability of an inundated farm is curtailed to enhance agricultural capabilities downstream.

Soil irrigability maps indicate the downstream river valley soils are superior to the bench lands surrounding either reservoir and to the valley lands to be inundated. In addition, irrigation systems can be developed for approximately $900 per acre for 8,000 acres of development in the river valleys compared to $2,600 per acre for a 4,000 acre development on the Alameda bench lands.

It is envisioned that irrigation development downstream will occur as quickly as water supplies are available while block development on the bench lands will be much slower. Bench land development will depend on much more favorable agricultural financial climates than exist today.

Footnotes

[1] Rafferty and Alameda Reservoirs, Conceptual Evaluation of Irrigation and Recreation Costs and Benefits, December, 1985.

[2] Background studies, Souris Basin Development Authority, June, 1986.

[3] Canada Land Inventory Sheets, Weyburn, Saskatchewan, EN64-5/6E.

[4] WRC, Appendix D.

[5] Background studies, Souris Basin Development Authority, June, 1986.

[6] Ibid.

[7] Ibid.

[8] Ibid.

[9] WRC

[10] Background studies, Souris Basin Development Authority, June, 1986.

[11] Source - Saskatchewan Agriculture, 1985, Farm Business Analysis Grain Enterprise Dk. Brown >1000 acres and WRC Appendix F.

[12] Yield - 26.2; Price - $4.40/bu/wheat;
Rotation: 50/50 wheat/summerfallow.

[13] Saskatchewan Agriculture, FBM Data Manual

[14] Calf Weight - 450 lbs; Price - $1.00/lb;
Calving percentage .90.

[15] Cow/calf unit losses are based on carrying capacities of 15 units per quarter section per season for grazing. A cow/calf unit loss of summer grazing represent total losses as costs and revenues in Table 13 cover winter feed costs. Grazing capacitities are based on surrounding public grazing leases: SBDA background report.

[16] Revenue losses are based on net agricultural losses of $8.94 per acre for cultivated cereals and $6.22 per grass acre.

[17] Management of Water Resources Within the Oldman River Basin, Environment Council of Alberta, 1979.

[18] South Saskatchewan River Basin Planning Program, Scenario Report, Alberta Environment, Planning Division, 1984.

APPENDIX THREE

FLOOD CONTROL

FLOOD CONTROL

Introduction

Flooding of the communities and farmlands in the Souris River Valley, and the effect of uncontrolled land drainage on flooding, has historically been perceived as a serious problem by many valley residents. The 1978 Souris River Basin Study(1) assessed urban and rural flood damages and alternative measures for flood control. As a measure of the problem, the study reported that in the 30 years prior to the study, nine high flow floods were recorded and seven of these floods were greater in magnitude than a 10 year return period flood.

Flooding in the basin is not characterized by an extensive inundation but by the flooding of discrete flood prone areas scattered along the river valley. The larger flood events are primarily the result of a combination of spring snowmelt and runoff, although some summer flooding does occur.

This section presents the results of a review of the previous studies of flood control carried out in the basin and a current estimate of the effect of the proposed Rafferty and Alameda Dams on future basin flooding.

Previous Studies

The Souris River Basin Study(1) conducted on behalf of the Governments of Canada, Saskatchewan and Manitoba provided the basis for flood control work in the basin. Study Supplement No. 2, Flood Damage Reduction included an assessment of urban flood damages based on a joint Canada-Ontario study carried out by Acres Limited(2) in 1968. This landmark study established depth/damage curves for a range of residential and commercial buildings and contents and created a methodology for estimating direct damage costs for most communities. Direct damage costs are defined as the actual physical losses than can be evaluated on the basis of the cost of restoring an object to its pre-flood condition, either by repair or replacement. In addition, the study established a method for estimating indirect damages as a percentage of direct damages. Indirect damages would be losses not caused by physical contact with flood waters such as loss of business or wages that could be measured in economic terms.

The Souris River Basin Study(1) utilized the Acres curves for residential and commercial damages combined with locally generated assessments of rural crop losses and damages to roads and bridges(3) to estimate Souris Basin flood damages. The study also identified Rafferty and Alameda Dams, among other measures, as potential flood control reservoirs.

Further studies of reservoirs in the Souris Basin were initiated by the Saskatchewan Power Corporation in 1983 and continued into 1985 with the Souris River Flood Study by Fennel, Cochrane, Lavalin(4,5,6) and involvement of the U.S. Army Corps of Engineers regarding flooding benefits in the United States.(7) These studies refined the earlier damage estimates by considering those portions of the basin which would be affected by the construction of the dams and by updating the damage estimates.

Flood Damages

Within the Province of Saskatchewan, the following categories of flood damage would be affected by construction of the Rafferty and Alameda Dams:

Urban:	R.M. of Estevan No. 5 Village of Roche Percee Oxbow - Beaver Park Subdivision (The Town of Radville is in the valley but is above the 500 year flood line)

Urban damage figures, by definition, include direct residential, commercial and public buildings; roads, lanes, streets and sidewalks; dams, highways, railroads and municipal bridges; and, indirect damages as a percent of direct damages.

Rural:	The Souris River Valley from Nickle Lake (Weyburn Reservoir) to the International Border.

Rural flood damage figures include damage to farm dwellings; spring and summer flooding of agricultural land; and, indirect damages as a percentage of direct damages.

Reservoir:	The Lutheran Bible Camp, Dr. Mainprize Regional Park, archaeological sites, oil wells, grid roads, water supply systems, gravel deposits, Weyburn sewage disposal and permanently flooded agricultural land.

Reservoir flood damage figures have been calculated independently of the earlier flood control studies and are discussed in detail in the mitigation cost estimates in other sections of this report. The reach of the Souris River from the Rafferty Dam to Nickle Lake requires special mention. This reach would be flooded by Rafferty Reservoir, but flood damage foregone as a result of the dam construction will be accounted for as a flood control benefit. The purchase of this land can be viewed as elimination of all future flood damages to these lands. The land acquisition costs are accounted for as a project cost.

Annual Average Flood Damage

The Souris River Basin Study⁽¹⁾ estimated potential damages from water levels experienced during extreme flood events ranging up to a 1 in 500 year return period for urban damages and 1 to 100 year return period for rural damages. The damage figures were derived from Acres⁽²⁾ depth damage curves, a systematic survey of the flood plain and valley communities, and, were updated to 1978 dollars.

The study established probability/damage curves and these curves were used to determine average annual damages. The area under the probability damage curves represents the sum of the products of all possible damages for the different flood frequencies times their respective probability of occurence in any given year plus the sum of the products of all the omitted intervening years.

The annual average damages, corrected to 1986 values using Consumer Price Index for damages are as follows:

Urban:			
	Estevan		$ 21,700.
	Roche Percee		8,830.
	Oxbow		570.
		Total:	$ 31,100.
Rural:			
	Lost Production		100,500.
	Dwellings		7,600.
			$108,100.
Total annual average damage -			$139,200.

Flood Control by Reservoir Storage

The temporary storage of stream flow during extreme floods and later release of the stored water when the critical flood conditions have passed is the most direct method of reducing flooding conditions downstream of the reservoir. The proposed Rafferty and Alameda Reservoirs combined with the existing Boundary Reservoir have the potential to provide substantial flood control of the Souris River downstream of the reservoirs. Earlier Canadian studies(4)(5)(6) have utilized a variety of multi-reservoir and single reservoir models to compute the downstream reduction of flooding when industrial, municipal, irrigation and recreation users are considered.

The studies established that the Rafferty Dam, with a temporary rise in reservoir level (or surcharge) of 3.5 metres during flood peaks, will significantly reduce downstream flood damage in Saskatchewan. Some minor damages will still occur from spillway releases during floods in excess of the 100 year flood event.

Alameda Dam will contribute to the reduction of flood peaks in Saskatchewan in the reach downstream of Moose Mountain Creek, but the storage provided in the Alameda Reservoir would be most beneficial for flood damage reduction in the State of North Dakota.

Flood Control by Diversion

The diversion of flood flows away from the river channel during extreme events is also an effective way to diminish flood damage. The proposed diversion channel from Boundary dam to Rafferty dam can reduce flooding from Long Creek by spilling into the Rafferty reservoir. On the basis of a recent study, "the economic benefits resulting from these reductions are not major, however, such reduced flooding will significantly reduce the hardships and inconveniences frequently encountered during spring flooding."(7,8)

Saskatchewan Benefits

The total annual average damage (urban and rural) downstream of the Rafferty and Alameda Dams, to the international border, was estimated to be $139,200. Elimination of these damages over a 50 year assumed economic life for the Rafferty and Alameda Dams, at discount rates of 5 and 10%, would provide a present worth of $2,541,100 and $1,380,100 respectively as flood control benefits of the structures.

Indirect Benefits

The indirect benefits accruing to flood control in the valley would be the decrease in the disruption of normal activities for residents of the flood plain. This has been reflected in the preceding damage estimates.

Upstream flood storage reservoirs not only provide protection to existing developments, this method of flood control also permits development where risk to development would otherwise be prohibitive. See the Quality of Life Appendix.

American Benefits

Serious and recurrent flooding of the Souris River has affected thousands of people in the City of Minot, North Dakota, outlying communities and agricultural areas. Construction of flood storage dams in Canada would provide flood control benefits to the United States. The U.S. Army Corps of Engineers,(9) in cooperation with Saskatchewan authorities, have evaluated the flood reduction potential of the Canadian Reservoirs alone, and in combination with raising Lake Darling, or, operating Lake Darling and providing levees or dyking in flood areas.

Quoting from WRC(10) report,

"Recent simulations carried out by the U.S. Army Corps of Engineers utilizing flood routing parameters provided by Saskatchewan on Rafferty and Alameda Reservoirs indicate that construction of these two reservoirs would provide a significant level of flood protection in Minot, North Dakota. Indications are that a combination of Rafferty Reservoir, Alameda Reservoir and operating Lake Darling (on the Souris River just upstream of Minot in North Dakota) would provide protection for nearly all of the 1:50 flood. Adding levees or dyking to this combination would provide protection up to the 1:100 year flood."

The Corps has determined that the United States will contribute $41.1 million, U.S., in October 1985 dollars, for construction of the Rafferty and Alameda Dams. This contribution amounts to some $60,000,000 Canadian.

Summary

The overall positive effect of the Rafferty and Alameda Reservoirs on flood control would be: from $1,380,100 to $2,541,100 as flood control benefits to Saskatchewan, a contribution of $60,000,000 towards reservoir construction costs from the United States and decreased disruption to agriculture, commercial and domestic activities in the flood plain.

Negative aspects relate to damages caused by flooding of the reservoirs. These aspects have been discussed and estimated in the project benefit cost statement.

REFERENCES

(1) "Souris River Basin Study; Supplement No. 2; Flood Damage Reduction; Volume 1 of 2" by the Prairie Farm Rehabilitation Administration, Canada Department of Regional Economic Expansion; Souris River Basin Study Board, December 1977.

(2) "Guidelines for Analysis: Streamflows, Flood Damages, Secondary Flood Control Benefits, Vol. 2: Flood Damages" by Acres Limited; Governments of Canada and Ontario, Joint Task Force on Water Conservation Projects in Southern Ontario, August, 1968.

(3) "Moose Jaw River Study, Appendix 3, Flood Plain Occupancy and Flood Damage" by the Qu'Appelle Basin Study Board, Canada - Saskatchewan - Manitoba, August, 1973.

(4) "Phase 1 Report; Rafferty Reservoir Multi-Use Feasibility Study; Vol. 1" by Fennell, Cochrane, Lavalin Inc.; Saskatchewan Power Corporation; September, 1983.

(5) "Rafferty Reservoir Study - Phase 2; Volume 1, Main Report" by Fennell, Cochrane, Lavalin Inc.; Saskatchewan Power Corporation; January, 1985.

(6) "Souris River Flood Study, Volume 1, Main Report," Cochrane, Lavalin Inc.; Saskatchewan Power Corporation; February, 1986.

(7) "Boundary to Rafferty Flood Diversion Channel Economic Analysis" Cochrane, Lavalin Inc.; Souris Basin Development Authority, February, 1987.

(8) "Rafferty Dam, Diversion Channel Study, Boundary to Line C" by Cochrane, Lavalin, Souris Basin Development Authority, December, 1986.

(9) "Lake Darling Flood Control Project, Souris River, North Dakota; Design Memorandum No. 3; General-Project Design" by the U.S. Army Corps of Engineers, St. Paul District; June, 1983, revised September, 1983.

(10) "Rafferty and Alameda Reservoirs, Conceptual Evaluation of Irrigation and Recreation Costs and Benefits, Volume 1, Main Report, Water Resource Consultants Ltd.; Saskatchewan Water Corporation; December, 1985.

APPENDIX FOUR

WATER SUPPLY

WATER SUPPLY

Introduction

Rural areas in the Souris Basin obtain their domestic and livestock water supplies from dugouts, wells and/or small dams. Municipal water requirements are obtained primarily from surface water and secondarily from groundwater sources. The cities of Estevan and Weyburn account for the majority of the municipal water use in the basin(1) and both utilize the Souris River as their primary water source. The Souris River and its tributaries, being typical prairie streams, derive most of their annual flow from snowmelt and early spring rains. Storage of spring runoff is essential and both cities use reservoirs to provide municipal supply during the remainder of the year.

The Alameda and Rafferty Dams will affect existing surface and subsurface water supply and water quality. This section discusses the review of previous studies and presents current estimates of the costs and benefits from construction of the two dams on the domestic and livestock water supply.

Previous Studies

The Souris River Basin Study Board(2), through various authors, assessed groundwater resources, water demand and made a preliminary evaluation of water supply projects in the Saskatchewan portion of the Souris River Basin.

Groundwater in the Saskatchewan Portion of the Basin is generally of poor quality because it is of high to moderate mineralization. It is, however, generally suitable for human and livestock consumption but is unsuitable for irrigation. "Hard water and high iron content are common properties of many of the groundwaters but they are a nuisance rather than a health concern."(2) In general, towns, villages and hamlets utilize groundwater as a water source. The two cities in the basin use surface water from the Souris River and rural domestic and livestock users rely on dugouts, reservoirs and/or wells.

Recent studies(3)(4)(5) have focussed on the development of the Rafferty and Alameda Dams primarily for cooling water, flood control, irrigation and recreation users. The most current Souris Basin Development Auth. background report (6) addresses the impact of the reservoirs on existing and future water demands. In general, development of the reservoirs will have little impact on the existing systems, will provide more reliable flow and less turbid surface water flow downstream of the reservoirs.

Direct Costs - Water Supplies

The Rafferty Reservoir will flood the municipal water intakes for the Town of Midale and the Village of Hitchcock. The intake for Midale is located near Dead Lake with a pipeline running north to the town. The Hitchcock source is from a well approximately 5 km upstream from the dam site with a pipeline to the village. With the creation of the reservoir, it will be necessary for Midale and Hitchcock to alter their water supply intakes. The costs of these alterations will be paid by the Souris Basin Development Authority.(6)

The Alameda Reservoir has no effect on existing municipal water systems.

Domestic wells flooded by either reservoir will be replaced, compensated monetarily, or an alternate water supply of similar quality provided.

The estimated cost of municipal water supply mitigation for Midale and Hitchcock is $15,000. An allowance of $385,000 has been provided for domestic water supply mitigation costs.

Indirect Benefits - Surface Water Supplies

Construction of major water storage facilities will provide more reliable year-round flows in the Souris River and Moose Mountain Creek. The downstream water quality should also improve due to the removal, by trapping sediment, of suspended material from surface flows. However, according to Cochrane Lavalin on Rafferty(4) "Conclusions with respect to the water quality analysis work are difficult to draw." .... "Periods of extreme drought such as the 1930's will result in a generally undesirable quality of water as would likely be found in most prairie lakes under similar conditions." ... "Under the more normal conditions likely to prevail during the lifetime of the facility the water quality should be similar to other prairie lakes. The reservoir should therefore be considered an overall asset to the region."

Indirect Benefits - Groundwater Supplies

The construction of the Rafferty and Alameda reservoirs will impact the groundwater resources near the reservoirs, as a source of recharge and of superior quality water that will improve the groundwater chemistry. Domestic and municipal wells in the drift aquifers will benefit from more stable, increased water levels and improved water quality.(7)

Summary

The overall economic effect of the Rafferty and Alameda Reservoirs on municipal domestic and livestock water supply is unpredictable. Reservoir water quality is dependent on future meteorological and climatic conditions. Groundwater response to the new reservoirs is similarly dependent on the reservoir water quality and the complex response of the groundwater flow regime, water table levels and groundwater quality to reservoir levels. Any costs or benefits attributable to changing surface water quality would be highly questionable and difficult to substantiate. The Rafferty Reservoir should supply better quality water to Midale and Hitchcock, however, and, the groundwater resource will benefit from more stable, increased water levels and improved quality.

Quantifiable costs are those related to relocation of existing water supply systems. In addition to these estimated costs, an allowance for mitigation of future water supply has been included as a project cost.

REFERENCES

Following is a list of the references referred to in this part of the report:

(1) Souris River Basin Study Report. Souris River Basin Study Board, June 1978.

(2) Souris River Basin Study: Supplement No. 3; Water Supply, Souris River Basin Study Board, June 1978.

(3) "Phase 1 Report; Rafferty Reservoir Multi-Use Feasibility Study; Volume 1" by Fennell, Cochrane, Lavalin Inc.; Saskatchewan Power Corporation; September 1983.

(4) "Rafferty Reservoir Study - Phase 2; Volume 1; Main Report" by Fennell, Cochrane, Lavalin Inc.; Saskatchewan Power Corporation; January 1985.

(5) "Rafferty and Alameda Reservoirs, Conceptual Evaluation of Irrigation and Recreation Costs and Benefits, Volume 1, Main Report, Water Resource Consultants Ltd.; Saskatchewan Water Corporation; December 1985.

(6) Background Studies, Souris Basin Development Authority, June 1986.

(7) "Rafferty and Alameda Reservoirs, Hydrogeological Environment and Impact Statement" Beckie Hydrogeologists Ltd. Souris Basin Development Authority, April, 1987.

APPENDIX FIVE

QUALITY OF LIFE IMPACTS

QUALITY OF LIFE IMPACTS:
BENEFITS AND COSTS
ASSOCIATED WITH THE PROPOSED
RAFFERTY AND ALAMEDA DAMS
SOURIS BASIN, SASKATCHEWAN

February 1987

INTRODUCTION

This report is part of the benefit-cost analysis section of the Environmental Impact Statement (EIS) of the proposed Rafferty and Alameda dams. The dams will be located in the Souris River System in Southeastern Saskatchewan. A companion project, the Shand Thermal Electric Generating Station, is treated separately. This report examines the impacts of the proposed dams on the quality of life of Saskatchewan residents. Terms of reference for this study exclude assessment of the downstream impacts on U.S. or Manitoba residents. Various economic impacts are treated in separate Appendices to the overall benefit-cost report.

Impacts on the quality of life resulting from the two proposed dams are expected to be regional in nature. Both costs and benefits will accrue primarily and almost exclusively to the people of the southeast corner of Saskatchewan.

Costs to the quality of life in the region are largely associated with disruption of existing patterns of activity. Benefits are generally associated with new opportunities which may emerge as a result of the new hydrological regime. Both costs and benefits have been assessed in the light of planned or likely mitigation efforts.

The analyses presented here have been adapted from conventional engineering and economic analyses of multipurpose water resources projects. Usual classifications of impact areas include:

- Agriculture;
- Water supplies for domestic and municipal uses;
- Recreation;
- Flood protection; and
- Economic stabilization, diversification, and growth.

Power benefits are expected to contribute a significant portion of the economic benefits due to the use of the Rafferty reservoir for cooling the Shand power station. Availability of electricity has been a significant qualitative justification for some power projects in Saskatchewan. In this case, however, the Terms of Reference limit our mandate to the Rafferty and Alameda dams, excluding the Shand power station. Availability of electricity to regional residents is unlikely to be materially affected by the presence or absence of the two dams. That financial benefit to the Power Corporation is not, however, expected to materially change the quality of life of regional residents. Consequently, power benefits per se have not been addressed in this analysis.

Several other issue-areas which do not normally appear in the more common quantitative formats are discussed. They include:

- Aesthetics;
- Regional pride;
- Cultural heritage;
- Social interaction; and
- Community stability and development.

In each section, selection of issues has been based on previous analyses of similar projects in other areas and on community concerns in Southeastern Saskatchewan. Each issue is then discussed in the light of available evidence, with conclusions being drawn about its relative magnitude and direction of importance. A summary section indicates the issue-areas under which the proposed project appears to be primarily beneficial, those under which it appears to be primarily detrimental, and those on which this project's impacts appear to be neutral.

The analyses in this document are based on many sources, including previous environmental and social impact research on the Souris valley.(1) An extensive database of hindsight assessments of major multipurpose water projects around the world has also been used as a source both for issues and for comparative analyses.(2) Reviews of literature examining similar projects, as well as interviews and documents specifically related to the current project, have also been used to focus the analysis on the proposed projects in the Souris valley.(3)

AESTHETICS

Issues of aesthetic value are among the most difficult elements of water projects for economic analysis to address satisfactorily. In the project region, water resources take on special value due to the arid climate. There are noticeable differences between attitudes toward water resources in the Palliser Triangle and in the more humid areas of the province. Water has value both to individuals at an emotional or spiritual level, and to society in terms of the opportunities for recreation and industry.

Value of Water in an Arid Land

The social implications of water scarcity are discussed in detail in another Appendix. It is important to recognize that most cultures value water in an aesthetic sense. Poetry, art and songs have major themes related to water in its many forms. The phenomenon is particularly strong in arid regions. (4)

The aridity of southern Saskatchewan has long been recognized. The expeditions of Captain Palliser in 1857 and Professor Hind in 1858 both noted the dryness of the region, with Palliser describing it as part of a"more or less arid desert." Palliser indicated that the dryness of what later came to be known as the "Palliser Triangle" was the major factor impeding the growth of settlement in the central part of the continent.(5)

George Spence and many others have chronicled the importance of water to prairie agriculture.(6) The drought years of the 1930's formed an indelible mark on the conscience of the province and the mandates of many of its institutions. That water is highly valued in the arid region of Saskatchewan is beyond question.(7)

Placing specific social values on the development of secure water supplies remains something of an art. Several authors, from Wittfogel to Maass and Anderson to Bryant, have noted the high implicit value placed on water resource development in arid regions.(8) In many cases, actual benefit-cost ratios of 0.5 of less have been adequate bases for approval of water development projects.(9)

In Saskatchewan's history, the actual Benefit/Cost ratio for the South Saskatchewan River project (Gardiner Dam, Lake Diefenbaker, etc.) was estimated by the Hogg Royal Commission in 1952 at approximately 0.4 using accepted estimating techniques - without discouraging the enthusiasm of proponents in all Saskatchewan political parties.(10) Within six years, the project had been authorized; the benefit-cost ratio being restated at approximately unity. The rationale for building the project was couched largely in non-specific values such as regional economic and social stability, new recreational resources, and long-term prosperity of regional communities. A number of water-based Provincial Parks, Regional Parks, Community Parks, Institute Camps and Cottage Subdivisions have been developed on the shores of Lake Diefenbaker since its creation.

One of the most poignant insights into the aesthetic value of water came in an interview with the late Dr. William Tufts of Outlook. (11) Dr. Tufts had served as general practitioner in Outlook during the ravages of the Dirty Thirties and had been recruited by the Saskatchewan Rivers Development Association to lead its drive for the dam. After many years of passionate commitment to the cause, Dr. Tufts was able to marvel before he died at the spectacle of the Canadian Olympic Sailing Trials taking place on Tufts Bay of Lake Diefenbaker "in the middle of the Prairies!" The literature of the early 1960's is replete with examples of the vision of a green oasis with plentiful water in the heart of the province.(12)

The importance attached to the Wascana development in Regina shows a similarly high level of aesthetic value. The image of the city is dramatically changed with and without Wascana. The water and asso-ciated recreation, the flocks of migratory birds, the surrounding parks (cultured and rough), and the riverside golf courses, all contribute to a major distraction from the city's natural climate and ecology.(13)

The power of the oasis image is typical of dreams in many other arid societies presented with the possibility of a water resource development. The visual image of greenery along the river banks and in the irrigated fields, the sight of a large body of water in the middle of an arid region, the smell of fresh water in hot summer, the sight and sound of waves tumbling onto a shoreline on a summer day - the images are clear to many residents of these regions. They are images which stir deeply held emotions. Water is important, especially if it is in short supply.(14)

The Rafferty-Alameda project stirs many of those emotions, yet it is more limited in scope. The construction of Lake Diefenbaker was the largest construction project in the Province's history. Its completion marked a dramatic change in the lacustrine resources for a wide area. The Rafferty-Alameda project is smaller in scale and more localized in its impact than the South Saskatchewan River Project (SSRP). The main reservoirs are not in the heart of a city, as is the case with Wascana. The prior existence of Boundary Reservoir satisfies some of the strong social desire for a water body. As a result, the aesthetic value of the project is reduced both in terms of the population it serves and in terms of the directness and frequency of its impact.

It is apparent, nonetheless, that significant aesthetic value remains. Without direct reference to economic values, the concept of the Rafferty dam in particular has won support from many people in the area. While the reasons for that support may sometimes appear vague, the vagueness can be attributed to the depth of the aesthetic values which motivates it.

Aesthetic Attributes

Among the attributes of water resource development in arid areas are the following:

- Water for survival;
- Water as a component of prosperity;
- Scenic views and their spiritual impacts; and
- Ecological fertility of wetlands.

In most arid areas, including the Palliser Triangle, water is a critical element in the question of survival. The suffering of malnutrition and family upheaval caused by the drought of the 1930's serves as palpable evidence of the critical importance of water supplies in this area. Without sufficient water, life forms retreat and die. For many of the farm operations in this region, and their urban suppliers and services, water supply is a critical issue. Inadequate supplies make many prospective operations borderline propositions. Secure known levels of water supply would enable risks to be properly assessed and reduced. People in both agricultural and urban areas could plan more accurately and expansively.

Additional water supplies, or at least additions to the basic secure level of supply, would allow more development. A stable and expansionary basis for development would create a more positive social and investment climate. The socio-psychological pressures associated with the fear of devastating drought would be replaced with an optimistic and enthusiastic view of the future. A major element of personal, familial, and community stress would be replaced with a sense of security and opportunity. Families and investors would both be more likely to put down roots, to invest their time and effort for the long-term.

Geographers have developed models of economic development in which the supply (or scarcity) of water is an important factor.(15) Studies of the development of Western Canada have often noted the importance of water supplies.(16) While deterministic models based on single factors of production have generally been discredited,(17) the importance of water supplies remains well understood in arid zones.

Regina's situation is illustrative. For nearly a century, Regina has feared restriction on its growth because of constrained water supplies. The City has periodically investigated a wide range of schemes to alleviate that constraint, from piping water from the South Saskatchewan River to the development of ground water sources and Buffalo Pound Lake as a reservoir.(18) Water scarcity is a recurrent issue in Southern Saskatchewan, for urban and agrarian activities.

It is hard to place a value on the creation of lakeshore vistas. The frequency with which they appear in popular literature and cultural themes, however, suggests that they are important. Indeed, their value appears to be proportional to the aridity of the surrounding area. Within the Palliser Triangle, the popularity of water- based recreation in Saskatchewan and its neighbouring states to the south indicates a high social value.(19) Recent patterns in real estate development in Regina, where artificial lakes and proximity to Wascana Creek have come to dominate the design of new subdivisions, further indicate the positive value of lakeshore views and water-front real estate in this part of the world.

While efforts such as the Prairie Wildlife Interpretation Centre of the Canadian Wildlife Service near Webb, Saskatchewan, have raised our appreciation for the flora and fauna of the prairies, there is no doubt that wetlands are more fertile than arid zones. Biomass measures alone show much higher rates of productivity.(20) Species diversity is also enhanced. Ecological theory generally holds that high productivity and especially high degrees of diversity are advantages in ecosystem balance.(21) It is also reasonable that a more diverse and productive environment will offer more opportunities for human involvement ,whether that be hunting, bird watching, or berry picking.

Aesthetic Costs

While environmental changes can sometimes be seen as positive by some people and negative by others, there are certain areas of frequent agreement. Among the generally accepted 'costs' or negative consequences of the Rafferty and Alameda projects are those aesthetic elements associated with the construction period itself, the reservoir-filling period, and the reservoir management regime.

Increased traffic, due to the movement of construction crews and equipment, will have deleterious consequences in some parts of the region. Those negative impacts include: increased dust from gravel roads; increased noise; increased safety risks; and possible deterioration of road surfaces. Some people may perceive those impacts as producing medical (respiratory problems due to dust inhalation) or actuarial (safety risks) consequences. Most people, however, are likely to see them merely as temporary but acceptable reductions in their quality of life particularly in this area of the Province which has experienced major project development such as coal extraction and the construction of the Boundary Dam Power Station.

The construction period is also likely to bring to Estevan in particular a significant incremental population of well-paid, single, male, 'bon vivants.' Some young women, their parents, and other parties may view this segment of the construction population and its reputed behaviour as reducing their quality of life. In fairness, it should be pointed out that the 'rogue male' is a minority, even on construction crews, and that many do settle down and become "solid" members of the community. The influx of construction workers often has some short-term negative consequences; it also often has some long-term benefits.

The Construction crews and their families will create a demand for housing. If those workers were encamped at or near the construction sites, local housing impacts would be relatively minor, with the exception of indirect impacts due to economic improvements accruing to local labour. Under a policy of reliance on local housing markets, rental units of various types are expected to face increased demand relative to a no-project situation. Should the housing market tighten appreciably as a result of these projects, then the quality of life of persons competing for housing would be diminished.

In practice, the market for rental units in the project area has been driven by other construction, mining, and petroleum projects in recent years. With the recent downturn in the petroleum industry in Saskatchewan, the local housing market may be able to absorb the demands of the crews associated with the two dams - depending a great deal on phasing with respect to other activities.

During the later parts of the construction phase and during the period leading up to regular operation of the reservoirs (reservoir-filling), recreational use of the upstream valleys will be suspended for most uses. Existing uses, especially in the Souris valley above the Rafferty Dam, may be diminished or eliminated as facilities are closed or relocated.

During this period, the sites are likely to attract curious onlookers, or 'sidewalk superintendents.' For those people, the interregnum phase itself is a source of significant recreation. The Gardiner Dam site, for example, drew many spectators during the construction period, becoming a preferred location of many family and group picnics. To this end the Authority is proposing to construct a viewing facility at both dam sites to permit safe public access during construction. Furthermore, boat launches and parks will be created along the reservoirs and access across the dams will ensure public access to the water and to the many viewpoints and vistas.

Summary

Aesthetic benefits are primarily related to the development of two new water bodies in an arid region. Subjective and objective data show that high values are placed on water in this region. As a result, the benefits of the Rafferty and Alameda reservoirs include a high positive value for the enhancement of the aesthetic component of the quality of life of regional residents.

Aesthetic costs include disruption due to the construction phase and loss of traditional uses of the upstream valleys. Other aesthetic costs would arise if the level of the reservoirs fluctuates greatly during prime summer recreation periods. The proposed operating plan for the reservoir addresses this.

With the exception of some of the construction period impacts, the negative consequences can be mitigated easily. Existing plans include the necessary mitigation measures. The benefits, on the other hand, cannot be provided without the dams. In conclusion, the aesthetic value of the projects appears to be very strongly positive.

CULTURAL HERITAGE

The cultural heritage of the Souris valley is expected to be altered in several ways as a result of the project. Some of the changes involve existing social patterns while others affect the preservation and appreciation of prehistoric artifacts.

Issues

Inundation of the Rafferty and Alameda reservoirs will eliminate some established agricultural activities and may alter some associated social patterns, such as neighbourly visiting. It will destroy Mainprize Regional Park and the Lutheran Bible Camp as they presently exist. Both Rafferty and Alameda are likely to affect many archaeological sites from pre-European times. The loss or alteration of those parts of our heritage varies in significance depending on the viewpoint of the observer, but remains a loss nonetheless.

Native Heritage

In the process of investigating the project, archaeological research has uncovered much new material about the use of the valleys by aboriginal peoples. Teepee rings and other artifacts have been discovered, examined, and classified. Knowledge has been organized and improved, and many more people have become aware of the existence and value of these sites. Those improvements in knowledge and awareness add to our cultural heritage. They are benefits of studying the feasibility of the project, but not of the construction itself.

Project construction would severely damage the further archaeological value of those sites unless further mitigation were undertaken. A cultural heritage centre to preserve and further research the artifacts would retain and expand much of the inherent cultural value. Economic analysis alone will be insufficient to assess the benefits and costs of such a centre - or to define its scope or mandate.

The value of the heritage sites depends on several factors. Among the more important are:

- Information about the heritage of existing Native peoples in Saskatchewan; and
- Knowledge about uses of the soil and topography by earlier civilizations.

In this respect, a multi-featured heritage centre would allow presentation of many area features, from teepee rings and other aboriginal artifacts, to coal mines, dryland and irrigation farming, and geological and other earth science features. Although construction of the dams could not be said to lead directly to such a cultural enhancement, it may prove to be the stimulus for the organizational effort required for a broader development of the region's cultural heritage.

Agrarian Culture

In addition to the economic benefits of irrigation, there are community level impacts of a growing reliance on irrigation farming. The dams are expected to lead to more irrigation than presently exists, and that change will have other impacts on the region.

Elsewhere, when irrigation has been used to enhance forage production, the resulting growth in the livestock industry has increased the number of families staying on the farm year-round. Employment has become more stable, less seasonal.(22)

Service businesses dependent on the rural community may see reduced fluctuations in their trade. Economic stability through drought control will make some other business and social forms more likely and more secure.

In most parts of the world, irrigators have differed from drylanders in several important cultural attributes. In earlier times in Saskatchewan, racial and religious prejudices often stood between irrigators and their dryland neighbours. While those barriers are becoming less severe over time, it is possible that the people attracted to the irrigation potential created by the reservoirs may differ in cultural backgrounds from current residents of the region. If the irrigation potential is utilized by existing producers, then that possibility would be nullified.

Agriculture with an irrigation component to it is likely to differ substantially from pure dryland cereal production. Should the irrigation potential be used for forage production, then increased livestock activity would convert a portion of the rural population to livestock patterns. Rather than intense bursts of activity at the time of seeding and harvest, with little on-farm requirements during the winter, livestock producers tend toward a year-round on-farm style. If such a shift were to become widespread, many cultural activities, from winter curling to summer softball, might be affected. Locations of activity and availability of participants would shift.

The history of irrigation in Saskatchewan suggests that irrigation potential is developed on a very gradual basis. Gradual development is unlikely to change cultural or economic patterns dramatically in the foreseeable future.

Recreation

The economic values of recreation are treated in depth in another Appendix. Economic valuation of recreational benefits and costs of water resources development has progressed greatly in the last fifteen years and now represents perhaps our best approximation of the economic valuation of one component of the quality of life. As a result, there is some overlap between the present section and the more economics-oriented Appendix on the subject. There are, however, still several elements of quality of life which are not perfectly described by economics.

Among the types of recreation expected to be affected by the Alameda ad Rafferty reservoirs are:

- Fishing;
- Winter ice fishing;
- Cross country skiing;
- Park utilization, including picnicking, camping and related activities; such as swimming and sunbathing;
- Boating and sailing;
- Water skiing;
- Sail-boarding
- Hunting (waterfowl and game);
- Nature hikes, wildlife viewing; and
- Cottaging.

Provided that the planned mitigation measures are carried out satisfactorily, the proposed projects are expected to enhance regional quality of life on all counts.

The history of such projects, however, in Saskatchewan as well as in other jurisdictions, suggests caution concerning the scope and implementation rate of mitigation and development work. Conflicts over operating procedures have also arisen between the beneficiaries of the various purposes of multipurpose schemes. Optimal agricultural usage, for example, requires summer draw-downs - which limit many of the recreational values of a stable shoreline.

An additional benefit resulting from the proposed project would arise from the relief of pressure on existing recreational resources in the Moose Mountain area. Provision of alternate fishing and boating resources may result in a significant drop in use of the Moose Mountain facilities. When regional recreation capacity increases almost 100% in a short period of time, it is likely that usage of existing facilities may be reduced to a point where they struggle for sufficient volume to maintain desired levels of activity and financial support. That is not likely to take place in a short period of time, since the development of aesthetically pleasing alternatives on the Rafferty and Alameda reservoirs will take several years. Reduced numbers at Moose Mountain Provincial Park on peak weekends will improve visitor satisfaction, ultimately resulting in renewed and increased visitation in the region.

The Rafferty dam reservoir will be within range of evening boaters, fishermen and water skiers from Estevan, Weyburn and surrounding communities whereas Moose Mountain Provincial Park is not. In addition to activity relocated from the existing lakes, there will be some incremental activity on the Rafferty reservoir. At this time, it is impossible to identify the current uses of the leisure time which would be reallocated to summer evenings on the Rafferty reservoir.

Summary

The dams will disrupt some existing cultural values, including some social and agricultural relationships. Dislocations associated with changed agricultural practices and family relocation may also affect the residents' sense of heritage. Inundation of the existing Dr. Mainprize Park could eliminate an important vestige of community effort and leadership - including its clear recognition of the value of water in the physical and spiritual recreation of the community. Relocation of that Park to an alternative site will, however, ensure that the vision and community spirit is carried forward to future generations.

Inundation by the reservoirs will likely diminish the medium-term value of numerous archaeological sites. Without the prospect of the dams, however, those sites would likely have remained unappreciated for an indefinite period, except possibly by a small group.

Proposed and considered mitigation measures, such as a heritage centre, the development of better recreational facilities, and more intensive agriculture, indicate that cultural, recreational, and agricultural concerns are being addressed. Indeed, the mitigation measures will produce new facilities and values which far exceed those which they are replacing.

The net effect of the projects appears to be quite positive, especially if the heritage centre and recreational facilities are fully developed with due recognition to the cultural heritage of the region.

REGIONAL PRIDE

How does the development of large water projects affect motivation?

Discussion of Benefits

Many of the more intangible benefits of water resource developments can be summarized through their influence on regional pride. Several communities, including Regina, have been stigmatized for their poor water quality. Removal of those stigmas allows a flowering of community pride which can lead to several important benefits.(23) Reduction of the negative self-images associated with drought and poor water quality, especially when those stigmas have become widely acknowledged, releases a great deal of optimism and enthusiasm, through the process of eliminating or reversing a deeply felt weakness.

Improved water supplies, in both quantitative and qualitative senses, can change a community's self-image. During the construction period and for several years thereafter, there can be a noticeable improvement in civic spirit. While that change in spirit has many tangible consequences for the material quality of life, it is perhaps most important for residents' sense of confidence in, and satisfaction with, their community and themselves.

Tangible benefits of water resource development (e.g., parks, irrigated farms, recreational resources) are important elements of the identity of dry regions. Transformation of those values can easily lead to changes in community self-image which in turn lead to changes in activities. Economic development campaigns become more enthusiastic with the improvement in amenities - and the elimination of a frequent objection to the sales pitch of the community's promoters. Local residents, with their enthusiasm, may also create a broader investment base which can in turn bring more outside investment.

The quality of personnel available will also improve as the amenities of the region become more attractive. As it becomes easier to attract highly qualified personnel to an area, it is also possible to build more sophisticated businesses on their talents.(24)

The sense of progress engendered by undertaking challenging and visible projects is another important intangible benefit. The Gardiner Dam, and many others like it around the world, have served to convince communities that they are indeed capable of great things, of growing beyond their existing capabilities.(25) In the process, those communities develop important skills in construction, management, and operation of large projects. Those skills may produce additional benefits if they can be exported in services, but their most tangible result usually comes from the expanded vision and confidence of the local people associated with the project. Having proven that they can accomplish something bigger than they had ever before attempted, they have evidence that they can accomplish even greater things.

The identity of the community changes as it proves it can accomplish major projects. When those projects also dramatically change the amenities of the community and its perceived quality of life, the combination produces an enthusiastic surge of confidence and pride. Under those circumstances, both the perceived and actual quality of life improve dramatically.

Risks

There have been situations in which major project development has led to the reverse of enthusiasm, confidence, and pride.(28) Disruption of existing social and economic bases, creation of environmental nightmares, and boom-and-bust construction phases, have combined to tear communities apart. The environmental problems have generally occurred in areas where major changes in regional climate and water balance are imposed on traditional cultures. Social problems have been worst when the new economic and social order after the project differs dramatically from the antecedent conditions. None of these conditions is present in the case of the Rafferty and Alameda projects.

The construction crews entering the community will be noticeable, but will hardly dominate the area. In fact, the southeast part of the province has hosted several major construction projects over the years and appears likely to do so in the future as the coal and oil resources of the area continue to be developed.

Farmers and city-dwellers alike are familiar with the development of new reservoir-lakes, through previous experience with Boundary Lake, and with other water projects in the province. Saskatchewan has a long history of water resource development. Lessons from that experience mean that both residents and administrators should be prepared for most of the situations which arise.

The economic changes induced by the dams will be minor in the context of the region. A small percentage of farms will develop irrigation facilities; a larger percentage, although still a minority, will have their grazing and stock-watering patterns altered somewhat. Some urban-based support services will be affected by the projects, but few will face major changes in their trading volumes.

Summary

The impact of the project on regional pride is expected to be solidly positive. Detrimental impacts on attitudes within the host region are relatively unlikely in this case.

WATER SUPPLY CHANGES

Issues

Implementation of the Rafferty and Alameda projects would have several impacts on the quality of life of regional residents through changes in the quality of water supplies. Some of those effects are transmitted through changes in groundwater, others through surface flows. The issues include: changes in the security of supply; costs of access or replacement of supplies; and quality of water.

Groundwater

Groundwater effects are likely to be driven by changes in hydrostatic pressure.(27) As the water table moves upward around the reservoir, pressure will improve in local wells. Groundwater supply will become more plentiful. Costs of drilling new or replacement wells are likely to decrease, making water supply more accessible and reducing household costs.

Quality of the groundwater will depend on the ground through which that water moves. While that will depend on local mineralization, the increased pressure and flow rates are generally expected to reduce the level of mineralization and improve the quality of the water for consumptive purposes. Expenditures on purification and softening are also likely to decrease.

Supplies will become increasingly secure as the reservoirs fill. That security, and the reduced costs of drilling wells into a reliable stratum, will improve the quality of rural life around the reservoirs.

Surface

Surface water will clearly become more plentiful. It is, however, likely to be quite slow moving. The average annual replenishment rates for the Rafferty reservoir at the 550.5 elevation is only 16%. For the Alameda reservoir, the average annual inflow is equal to 23% of the volume at an elevation of 574 m.(28) That low rate of turnover suggests that these reservoirs may, at times, develop some of the characteristics of many prairie reservoirs. While the presence of the water bodies will add to the aesthetics of the regional environment, and to its recreational opportunities, the potential for stagnation could reduce those values.

In other respects, however, the existence of the reservoirs will improve the secure supply of water for all purposes by capturing the peak floods and redistributing them across low flow periods.

Summary

The reservoirs are likely to increase both quality and quantity of water available in the region for all purposes. While there must be some concern about the delivered quality of the water, it appears likely to be an improvement over the existing situation. In general, improvements in security, economy, and quality of water supplies will improve the quality of life of regional residents.

FLOOD PROTECTION

Flood protection, like recreation in some ways, is one of the areas of project evaluation where economic tools have successfully captured some of the qualitative benefits. Yet the standard financial values of the insurance adjuster and actuary do not accurately reflect all the dimensions of flood protection. Estimation of flood damages by application of insurance claims against depreciated cash value of goods, for example, grossly underestimates the human suffering caused by the loss of cherished household effects. Even the application of replacement costs fails to address the emotional loss.

The Terms of Reference for this study restrict it to Saskatchewan impacts. The willingness of the Americans to contribute approximately U.S. $41.1 million (October 1985 dollars) for flood control, however, does indicate the order of magnitude of their valuation of the flood control benefits. While larger populations and higher levels of economic assets are threatened by Souris floods in the U.S. than in Saskatchewan, the importance of flood control to Saskatchewan residents remains.

Issues

The Rafferty and Alameda dams will provide flood protection for downstream residents. For a few upstream residents, however, filling the reservoirs means that their farmsteads will be inundated. Thus flood protection for many means destruction for a few.

Creation of reservoirs requires inundation of valley bottomlands. Operation of the reservoirs for flood protection can create an intermediate zone which is flooded for peak storage, but otherwise uncovered. Each of those situations involves costs to the quality of life of regional residents. On the other side, however, the benefits of flood protection include such intangible elements as the reduction of fear, the increase in peace of mind, and the potential development of protected downstream lands.

Costs

On the cost side must be seen the permanent flooding of the existing bottomlands upstream from the dams. At least in the case of the Rafferty reservoir, those bottomlands are quite productive. While the fertile valley floor is limited in size and productivity, its inundation will cause a permanent loss of its production - and of the agricultural activities linked to it. Aerial inspection suggested that cropping in the Rafferty reservoir area was primarily to provide forage for livestock. Those benefits of the existing valley will be lost. In addition, at least two farmsteads will be inundated and another may be seriously affected by the construction, depending on the final design of the Rafferty Dam.

Other disruptions will occur as existing grazing patterns on the flanks of the Souris are divided by the new reservoir. There may be some dislocation of farm families as land holdings are rationalized.

All of these are costs in the sense that they indicate a deterioration of the status quo due to flooding caused by the dams. Allowances will be made in the project budget for the disruption the projects impose on affected landowners as was carried out on large projects in Saskatchewan at Coronach and Nipawin.

In general, the costs of flooding involve only a few families and individuals and economic compensation is relatively straight-forward. For a project of this magnitude, the number of families suffering relocations is remarkably small. While no real value can be placed on the personal impacts of relocation without reference to specific cases, the social impact of this project is slight compared to others where large populations inhabited the future reservoir.(29)

Benefits

The Souris River has a history of frequent flooding and of wide fluctuations in the rate of flow. As a result, the fear of flooding is quite evident in land use patterns. Populations generally avoid the valley and stay on higher and safer ground. While the communities of the Souris basin are generally located close to the river, few exhibit significant emphasis on water front development or highly valued waterfront property. In fact, the new subdivisions in Estevan are developing on the opposite side of town.(30) In many other communities, waterfront property is highly prized, attracting premium prices and developments.(31) Given the high cultural importance attached to water on the prairies, one can conclude that the absence of such developments in Estevan, Alameda, etc. stems at least in part from the dangers associated with flooding.

Reduction, if not elimination of that danger will likely lead, over time, to enhanced development of recreational resources along the waterfronts. Golf courses, parks, playing fields, etc. all make good use of a flood plain. The advantages of that sort of development in arid Saskatchewan are especially strong, since the combination of a steady source of irrigation water with the more fertile soils allows development of greenery which is uncommon and very expensive on higher ground.

Improved recreational resources strengthen the aesthetic qualities of life considerably. They also make park-front property more attractive, zoning conditions permitting. Adjoining hospitals, senior citizens residences and other institutional uses in other communities indicate the social value associated with park settings. Real estate developments may also shift to take advantage of the aesthetic value of the waterfront once it becomes stabilized.

Economic assessments alone do not reflect the insecurity associated with living on the Souris flood plain. Residents in the valley below Estevan are annually faced with the possibility of losing their homes and belongings. While the full implications of the dam for property development are unclear because of the federal restriction on building within the 500-year flood zone,(32) it does seem likely that existing developments will be valued more highly due to the increased level of security. Personal, family, and community trauma due to flooding is likely to become a more uncommon experience.

Summary

Costs of flood protection fall disproportionately on a small segment of the population. Supplementary compensation has been provided to mitigate the social costs of relocation. Benefits are more broadly spread among downstream users, and include significant psychological relief from fear of flooding. Over the long term benefits to the quality of life appear to significantly outweigh costs.

IMPACTS DERIVED FROM ECONOMIC CHANGES

Economic impacts of the proposed dams are assessed elsewhere in this report. Those impacts, both indirect and direct, are defined and measured in terms of economic changes. The central concern of this section is the implications of those economic changes for the quality of life of regional residents.

This impact assessment is organized according to the following types of economic change:

- o Growth;
- o Diversification; and
- o Employment.

Economic Growth

Economic growth, both permanent and temporary, has numerous implications for the quality of life. Perhaps the most obvious confirmation of the correlation between the two is the extent to which political leaders treat economic growth and its associated features, such as employment, as a social benefit. "A chicken in every pot", " A car in every garage" and "Saskatchewan Builds" are statements of support for economic growth as a social good. A wealthier society is generally presumed to be happier than a poorer society. Other things being equal, economic growth means wealth and progress.

Economic growth implies change. Most people find change disruptive, and many fear or resist it for that reason. Growth means that old ways of doing business may not be good enough anymore; old firms have to renovate their practices or go out of business. Growth has a price in its concomitant turmoil. For those who adapt, there are important benefits.

Regional economic expansion means greater support for advanced services such as schools, medical specialists, air transportation links, business services, government offices, and technical training. Many services are sized to suit the 'market area.' For a population of a given size, some services may not be available at all, or may be available at a distance, or in reduced form. As Estevan hovers around the 10,000 population mark, additional jobs and population are important to its ability to attract those services. Its total retail sales are approaching $100 million annually, another important threshold for decisions about business locations.(33)

Growth has important psychological attributes as well. A growing community attracts investment in businesses and institutions which might not be justifiable if based only on existing levels of demand. With good prospects for growth, those investments become more attractive to planners anticipating larger demands in the future. Families are also encouraged to put down deeper roots if they expect a growing number and variety of opportunities for themselves and their children.

If one examines the promotional economic development literature from a sample of communities, it is apparent that the quality of life in those communities is an important element in their pitch to attract new businesses.(34) Recreational facilities, parks, golf courses, etc. are highlighted in the developers' messages. The happiness of employees is influenced in many ways by the quality of their environment outside the place of business. Happy employees make for productive and successful businesses.

Improved water supplies have both a direct industrial impact (making water available for industrial uses) and an indirect one (making water available for qualitative uses). It is a synergistic effect that is exploited by those communities which have the asset.

Economic Diversification

The Alameda and Rafferty dams are part of a larger-scale economic development plan. For the urban areas, primarily Estevan, the development of the coal and power industries offers the long-term benefits of a major anchor industry. In the rural areas, the expansion of irrigation and the livestock industry also offer the benefits of economic growth, diversification, and stability. Both rural and urban areas will benefit from population growth and expanded services. Diversification spreads the risks associated with basing the region's economy on any one industry, such as grain farming or coal exports.

The industries most directly served by the Rafferty and Alameda projects (and the associated Shand coal-fired power station) are natural expansions of the existing economy. The impacts, skill requirements, and opportunities are therefore well understood. The community will graft them onto existing patterns of behaviour more readily than it might with less well-understood economic activities.

The dams also create some opportunities which complement existing activities. The interest in recreational water bodies and the interest in environmental and cultural heritage can be served through the elaboration of such mitigation measures as regional parks and interpretation centres. Those facilities will, in turn, create their own form of economic diversification, offering jobs in the recreation, tourism and cultural fields.

Employment

The economic implications of new jobs, wages and procurement associated with the projects are treated in other parts of the EIS.(35) The present section deals with the impacts of the creation of employment on the quality of life.

Creation of employment is widely seen as a benefit for several reasons:

- Economic benefits of employment permit higher material standards of living;
- Dignified work is fulfilling for many people;
- Creation of long-term community assets gives people a feeling of contribution, often extending to their descendants for generations afterward; and
- Ongoing employment, through maintenance and recreational support, produces a long-term stream of benefits for the region.

There will be impacts of the construction effort itself, while other effects will stem from the operational period. There will also be impacts resulting from expansion of irrigation and livestock activities, as discussed earlier in this report.(36)

Lasting effects on the quality of life depend a great deal on the level of local labour content in all phases of project development. If direct employment is dominated by local people during the construction phase, then retained wage receipts, skills, and permanent labour force are likely to be stabilized and improved by the projects.
Impacts of imported labour are more difficult to assess, since they depend on the flow of the wage receipts as much as on the attitudes of the imports. Individuals who arrive for the project and then decide to settle in the region have significantly different implications for the long-term health of the community from ones who are transitory.

Increased employment means population growth, and increases in associated services. Long-term impacts come with the increases in permanent population which allow the introduction of new diversity in services. The number of banks serving the community may increase, or a new type of specialist may become justified at the regional hospital, for example. If the temporary surge is sufficiently lucrative, some new firms will have the incentive to set up shop and will be able to pay off their capital costs, allowing them to remain in business after the surge simply by covering cash costs. New businesses may thus join the community through the stimulus of a major project where they would not normally be capable of surviving.

Forecasts of the impacts of the project on the availability of services in the region predict that some services will be placed under stress due to increased population densities in the short term. (In the longer term, densities tend to revert to normal through loss of clients or increased employment of service providers.) Married men, for example, if accompanied by their families, will cause a temporary surge of children into the school system. Social services, and other infrastructure, will face a temporary surge in demand. If staff or expenditures are expanded to meet that demand, contraction after the surge may prove painful and/or costly. The problems of communities facing a major project surge have been documented by several authors.(37) The 'boom and bust' syndrome is a recurrent theme in Canada, with our large number of resource communities.

Thresholds for the provision of services vary sufficiently that precise delineation of all of them is not merited in this review. Rather, the general trend toward diversification, supported by population growth, is the key conclusion.

Once the reservoirs are in place, there will be a demand for operational staff. Actual levels and skills depend a great deal on operating policies and parks development activities. It is likely to be outdoor work and some of it will be seasonal. The skills required are likely to make it relatively easy for some of the construction labour force to find permanent employment in the area.

Other employment opportunities will be created through spin-off activities in the service industries, or in infrastructural activities such as municipal road-building.

These two dams are likely to contribute positively to regional growth. They involve skills and activities which are complementary to other regional projects.

Summary

The projects are likely to stimulate regional economic growth and diversification. They will foster growth in employment in operations and services. Growth and change imply some disruption of existing patterns of behaviour, commerce, and association. Enriched services are possible as economic prospects make investment attractive and as population and economic activities hit threshold levels.

SUMMARY OF QUALITY OF LIFE IMPACTS

Personal Values

Development of the Rafferty and Alameda dams may reduce opportunities for personal enjoyment of those parts of the existing valleys which will be inundated. Rough land for roaming, hunting, and nature appreciation will be reduced, although mitigation measures are intended to provide even better resources for all of those activities. Public access to such land will actually be improved many times through the creation of new parks.

Enhancement of some aesthetic values will result from the creation of the new reservoirs, provided the operating regime maintains relatively stable levels during the summer months. The aesthetic value of water bodies was shown to be quite high in this region due to the normally arid nature of the land. Public access to the water and across the dams will again contribute to the benefits associated with the aesthetic value of water.

Pride in the region and its features will be enhanced by the development of the water resources. Stronger senses of pride and community spirit, combined with the economic stability induced by growth and diversification, will improve investment and population growth.

Social Interaction

Existing patterns of land use will be disrupted for a significant number of people living in or near the valleys. In some cases, land holdings will be split by the new reservoirs. In a very few cases, the farmsteads will be inundated. Some turnover in the population is expected as existing operations are rationalized and new irrigation and livestock tracts are developed. Some friendships and other social interactions will be disrupted.

There is provision in the proposed mitigation measures for monetary compensation for social costs. Other mitigation measures propose to retain or improve transport access to each side of the reservoirs and to maintain or improve community water supplies. Recreational and cultural facilities will also be enhanced.

Further development of irrigation and the livestock industry will help to stabilize the rural population on a year-round basis at increased densities.

Urban populations will bear the brunt of transitory demands for service demands during the construction period, but will also derive the greatest benefit from increased services, population, and economic activity resulting from the projects.

Economic Derivatives

The dams will stimulate local expenditures, bringing jobs, expertise, and materials to the region. The economy will be enhanced through growth, diversification, and amenities. It is likely to become more attractive for additional investment and growth. The proposed developments are in line with present activities, making it likely that existing skills and capabilities will be fully utilized in the construction and operation of the new facilities. In addition, the projects will graft easily onto existing operations, rather than requiring whole new ways of doing things.

Losses of existing valley bottomlands are likely to be painful to current operators. On a regional basis, however, the improvement in facilities and water supplies is likely to make a considerable overall improvement in opportunities and amenities.

Attitudes

One of the most sensitive elements of quality of life lies in the mental attitudes of residents. A sense of defeatism, or shame about poor water supplies, could translate into eroding investment and population bases in a period of prolonged stagnancy. In contrast, major projects rarely have that effect. On the contrary, they are almost always seen as progressive measures indicating the strength and vitality of the host community's future. Those attitudes project out to potential immigrants, establishing them with positive attitudes on entry to the community.

Conclusion

When the proposed mitigation measures are fully implemented, the Rafferty and Alameda dams will significantly enhance the quality of life in southeastern Saskatchewan.

NOTES

(1) Background reports, Souris Basin Development Authority; June (1986).

(2) Thomas A. Bryant (1982) Big Dam Politics: A Hindsight Evaluation of Large Multipurpose Water Projects Ph.D. Dissertation, M.I.T.: Cambridge, Mass.

(3) For a recent assessment of the state of the art in social impact assessment, see: Diane Erickson (1985) A Comparative Analysis of Two Social Impact Assessment Studies Canadian Environmental Assessment Research Council: Hull.

A broader treatment of the state of the art in impact assessment, including qualitative elements, is developed in: David A. Munro, Thomas A Bryant, and A. Matte-Baker (1986) Learning from Experience: A State-of-the-Art Review and Evaluation of Environmental Impact Assessment Audits Canadian Environmental Assessment Research Council: Hull. See also: Gordon E. Beanlands and Peter N. Duinker (1983) An Ecological Framework for Environmental Impact Assessment in Canada and its associated Annotated Bibliography by Duinker and Beanlands, both published by the Institute for Resource and Environmental Studies, Dalhousie University: Halifax; in Cooperation with the Federal Environmental Assessment Review Office: Hull.

(4) For a massive taxonomy of the interaction between human beings and water resources, see: Stephen J. Fitzsimmons and Ovadia A. Salama (1973) A Social Report - Man and Water, The Relationship between Social Psychological Systems and Water Resources

Development Abt Associates Inc.: Cambridge, Mass.; prepared for the U.S. Bureau of Reclamation: Denver.

C.C. Warnick and C.E. Brockway (1974) traced the history of a water development theme back over 100 years for the Boise Post-Audit Study, Hydrology Support Section Completion Report, Idaho Water Resources Research Institute: Moscow, Idaho. George Spence (1967) (Survival of a Vision Historical Series No. 3, Canada Dept. of Agriculture: Ottawa) and Bryant (1982), op. cit. traced the history of the Gardiner Dam concept back over a similar period. Bryant (1982) and others have argued that projects such as the Aswan Dams in Egypt and the Mahaweli Ganga project in Sri Lanka can be traced back many centuries into the water-related myths of ancient predecessor civilizations.

See also Wissler, Clark (1926) The Relation of Man to Nature in Aboriginal America A.M.S. Press: New York. Wissler demonstrates the pervasive nature of worship of river spirits among previous civilizations in this part of the world.

John Graves (1971) pointed out that later settlers have continued to recognize the importance of water supplies to their way of life: "... in Texas as in most of the West, water development ranks with mothers and anti-communism as an automatically positive subject." [p. 45 in "Texas: you ain't seen nothing yet," in R.H. Boyle, et al. The Water Hustlers Sierra Club: New York and San Francisco; pp. 18-132.]

(5) For a more modern account of Palliser's expedition, see Irene M. Spry (1963) The Palliser Expedition: An Account of John Palliser's British North American Expedition (1857-1860) Macmillan of Canada: Toronto. Captain Palliser's expedition

was commissioned by the British government; his reports were presented to both Houses of the British Parliament on May 19, 1863.

Hind's exploration activity is reported in "Assiniboine and Saskatchewan Exploring Expedition - Canada," part of the product of the S.J. Dawson Exploration Expedition (Commissioned by the Canadian colonial governments), of which Prof. Hind was in charge of a division (after Spence (1967), p. 12).

(6) Spence (1967), op. cit., has provided an historically rich and passionate account of the tenacious development of the South Saskatchewan River Project (Gardiner Dam). For an alternate version of the story, see Bryant (1982) op. cit.

(7) Saskatchewan's concern with the dry years shows in many forms. Perhaps the best story ever told of that period in the 1930's - and its aftermath in human motivation - was presented by veteran writer James H. Gray (1967, 1978) as Men Against the Desert by Western Producer Prairie Books: Saskatoon. Consider also the anecdotes collected by Broadfoot (1973), the stories of Stegner (1955) and many of the community histories, including the Oral History Program collection.

Barry Broadfoot (1973) Ten Lost Years, 1929-1939: Memories of Canadians Who Survived the Depression Doubleday: Toronto and New York. Wallace Stegner (1955) Wolf Willow: A History, A Story and a Memory of the Last Prairie Frontier Macmillan of Canada: Toronto.

(8) For Wittfogel's writing on the importance of water resources in the development of economic and political power, see: Karl A. Wittfogel (1956) "The Hydraulic Civilizations," pp. 152-164 in Wm. L. Thomas, Jr., ed. Man's Role in Changing the Face of

the Earth, published for the Wenner-Gren Foundation for Anthropoligical Research and the National Science Foundation, by the University of Chicago Press: Chicago and London. A more complete version was published as Karl A. Wittfogel (1957) Oriental Despotism: A Study of Total Power Yale University Press: New Haven.

Arthur Maass' distinguished work on the motivations and results of water engineering projects includes: (1949) The Kings River Project published for the Inter-University Case Program by Bobbs-Merrill: Indianapolis; (1951) Muddy Waters: The Army Engineers and the Nation's Rivers Harvard University Press: Cambridge, Mass.; (1966) "Benefit-cost analysis: its relevance to public investment decision," Quarterly Journal of Economics 80: 208-226; and (1970) "Public investment planning in the United States: analysis and critique," Public Policy 18(2): 211-243. Through more than three decades, Maass has remained a persistent and effective critic of misplaced rationality in American water resources planning.

In co-operation with Raymond L. Anderson (1977), Maass has also produced a seminal analysis of the role of aridity in social development: ... and the Desert Shall Rejoice: Conflict, Growth, and Justice in Arid Environments the M.I.T. Press: Cambridge, Mass.

(9) An Ontario project once proceeded when "only 44 percent of project costs were justified", according to J. Chadwick Day (1974). Day also noted that many of the social benefits claimed by the project planners on the Deer Creek project were obviated by unmentioned losses of environmental quality, such as the elimination of one of the best sport fishing streams in the region. J. Chadwick Day (1974). "Benefit-Cost analysis and multiple-purpose reservoirs: A reassessment of the

Conservation Authorities' Branch Deer Creek project, Ontario," pp. 23-34 in Francis M. Leversedge, ed. Priorities in Water Management Western Geographical Series, Volume 8, Dept. of Geography, University of Victoria, Victoria, B.C.

Haveman (1972) showed that actual performance covered a wide range, including sub-unity ratios, on U.S. projects while Bryant (1982) demonstrated a broad pattern of under-implementation. Robert H. Haveman (1972) The Economic Performance of Public Investments: An Ex-Post Evaluation of Water Resources Investments Resources for the Future/The Johns Hopkins University Press: Baltimore.

The important points in the present discussion are: a) many projects are approved that have benefit/cost ratios less than unity, indicating that they are undertaken despite appearing to be bad investments; and b) that such approval demonstrated that some other factor must be left unmeasured by the economic techniques of estimating a project's value. Furthermore, the unmeasured portion which makes the difference is sometimes large enough to overcome more than half of the cost of the project. Samuels (1980), Shulman (1980), and Bryant (1982) have all advanced theories to explain this gap between social value and what is measured in conventional economical benefit-cost analysis. See: Samuels, Richard (1980) The Politics of Regional Policy in Japan Ph.D. Dissertation, M.I.T. Dept. of Political Science: Cambridge, Mass.; and Schulman, Paul R. (1980) Large-Scale Policy-Making Elsevier: New York.

(10) In 1952, the Hogg Commission conducted an extensive analysis of the SSRP, concluding that the actual costs of the project were likely to approximate $250 million, compared to earlier cost (and benefit) estimates in the $100 million range. While the Commission's report was sufficient to persuade the St.

Laurent Liberals to keep the project in limbo, it appeared to heighten the political support for the project in Saskatchewan, leading to its authorization by the Diefenbaker government of 1958. Canada, Royal Commission on the South Saskatchewan River Project (1953) Report Queen's Printer: Ottawa.

(11) Interview of Dr. Tufts in Regina by Tom Bryant, 1980.

(12) See, for examples, the publicity material of the Saskatchewan Rivers Development Association and the recreation plans for the Diefenbaker Lake area.

(13) The images of Wascana continue to dominate the City's publicity material. In a typical example, the cover page of the "City on the Horizon" supplement to Trade and Commerce Magazine (July 1986) shows the tall downtown buildings over a foreground of Wascana trees and water. Inside, the pictures of recreation activities are dominated by Wascana: parkland, canoeing, sailing, and wildlife. Publicity material prepared for general distribution by the City in 1984 described Wascana as Regina's "most distinctive feature." The popularity of Wascana is reflected by the listing in the 1986 phone book of 27 organizations (public and private) which have adopted the name.

(14) For a more complete discussion of the scarcity theme, see the companion Appendix on "Scarcity."

(15) Prof. Robin Hough (ca. 1978), in an unpublished paper, developed a world peace model built around the correlation of population growth with water supply. Similar to the broader "lateral pressure" model of Choucri and North, Hough positted that water supply constraints faced by growing populations and economies led to expansionary attitudes. Where one centre's

expansion collided with existing water users, conflicts resulted. [For the Choucri and North version, see: Nazli Choucri and Robert C. North (1973) Nations in Conflict Freeman: San Francisco.]

Closer to home, there have been many Canadian volumes which emphasize the importance of our water resources to the economic future of this country. For a sampling, see: the Royal Society of Canada, Claude E. Dolman, ed. (1966-67) Water Resources of Canada University of Toronto Press: Toronto; J. S. Cram (1968, 1971) Water: Canadian Needs and Resources Harvest Huse: Montreal; and J. G. Nelson and M. J. Chambers (1969) Water: Process and Method in Canadian Geography Methuen: Toronto.

(16) For early notices, see Spry's (1963) account of the Palliser Expedition op. cit., Spences's (1967) account of numerous investigations concerning water development op. cit.; and Nelson's (1976) study: Man's Impact on the Western Canadian Landscape The Carleton Library (No. 90), McClelland & Stewart: Toronto.

(17) Harold and Margaret Sprout (1967) presented a lucid analysis of the major environmentalist theories of development in The Ecological Perspective Princeton University Press: Princeton, N.J.

(18) Personal files and interviews by Tom Bryant. See also Spence (1967) op. cit.

(19) See the companion Appendix on "Recreation."

(20) See, for example, the discussion at pp. 50-52 in H. T. Odlum (1971) Fundamentals of Ecology W.B. Saunders Co.: Toronto and Philadelphia.

(21) pp. 148-154 in Odlum (1971), op. cit.

(22) A broad examination of issues related to irrigation development and its social impacts was published as: Theodore E. Downing and McGuire Gibson, eds. (1974) Irrigation's Impact on Society The University of Arizona Press: Tucson; (Anthropological Papers of the University of Arizona, No. 25).

(23) A discussion of political and social impacts of water projects is developed in Bryant (1982) op. cit. The recent emphasis on water quality by Regina's Mayor, Larry Schneider, supports the thesis that improvement of Regina's image for potential investors is linked to improvements in its water supply.

(24) A recent study of locational factors affecting high-tech zones in Canada was conducted by Dale Butler, formerly of the Saskatchewan Dept. of Science and Technology, as part of his Ph.D. research at the University of Southern California. For an interesting summary of Prof. Butler's findings, see: Dale Butler (1985) "High Technology: A Physical and Economic Overview," Address to the Regina Chamber of Commerce, High Technology Committee. Prof. Butler confirmed earlier studies which suggested that recreational and cultural amenities are very important in attracting key staff for high tech ventures.

(25) Indeed, Bryant (1982) argues that this intangible motivational benefit may be more important than the material benefits which are normally used to justify the projects. Accepting that argument would provide further understanding of the circumstances under which sub-unity benefit-cost ratios are associated with approved projects. Intangibles can sometimes be more valuable to people than those values which we can measure with normal economic and financial tools.

(26) Bryant (1982) opened his dissertation with a long catalogue of perceived ills of major water development projects. His analyses showed that many of those problems have consistent and common causes stemming from inadequately adapted technologies and insensitive planning.

(27) Background Reports, Souris Basin Development Authority; June (1986).

(28) Ibid.

(29) The plight of the Cree of northern Quebec in the face of the James Bay development is familiar to many Canadians. The implications for development of the Churchill River power sites in northern Saskatchewan and Manitoba have been examined in some detail. Evidence from more arid areas includes some of the work on the Nubians relocated to make way for the Aswan High Dam, the Akawaio in Guyana, and the people of the Volta in Akosombo reservoir in Ghana. For further information, see:

Canada, Minister of the Indian Affairs and Northern Development (1982) James Bay and Northern Quebec Agreement Implementation Review Ottawa.

Lake Winnipeg, Churchill and Nelson Rivers Study Board (1975) Summary Report Winnipeg. See also the scientific study by the Freshwater Institute, published as a special volume of the Canadian Journal of Fisheries and Aquatic Sciences 41(4): April 1984.

Letitia E. Obeng (1978) "Starvation or Bilharzia? - a rural development dilemma," in Water and Society: Conflicts in Development Carl G. Widstrand, ed.; Pergamon Press: Oxford; pp. 343-350.

David Hart (1980) *The Volta River Project: A Case Study in Politics and Technology* University of Edinburgh Press: Edinburgh.

William Henningsgaard (1980) "National development or cultural survival: the Upper Mazarume Dam in Guyana," Harvard University: mimeo.

(30) Between 55 and 75 new homes have been built in Estevan in the past three years. Of those new homes, approximately 40% have been built by amenity-conscious owners, typically a strong market for water-front property. Unlike Reginans, Estevan consumers are placing their valuable homes as far from the river as possible. [Data based on interviews with the City Clerk and City Engineer, Estevan.]

(31) For an empirical discussion of the many issues associated with flood plain use, see: L. Douglas James, E.A. Laurent, and D.W. Hill (1971) *The Flood plain as a Residential Choice - Resident Attitudes and Perceptions and Their Implications to Flood Plain Management Policy* Completion Report ERC-0671, Environmental Resources Centre, Georgia Institute of Technology: Atlanta.

(32) Federal legislation prohibits development within the 500-year floodplain, but provincial legislation is required to enforce that zoning condition in most areas. Saskatchewan has not endorsed the federal requirement, leaving in limbo the question of the development within the floodplain, at least for the time being.

(33) Data taken from the 1986 "Community Profile" published by the Sask. Dept. of Tourism and Small Business.

(34) Current examples include: Brantford, Ontario, which emphasizes its river location and the heavy commitment of the City to beautification of the municipal parks - an attitude reflected by many residents on their own property; Saskatoon, which emphasizes its river location and bridges ("The City of Bridges"); and Regina, which emphasizes the qualities derived from the Wascana development. Many other examples are possible.

(35) For a detailed examination of employment impacts, see: Foster Research (1985) *The Economic Impact of the Next Major Power Project in Saskatchewan*

(36) Section on "Agrarian Culture," pp. 13-14.

(37) See, for example, the treatment by J.A. Riffel (1975) *Quality of Life in Resource Towns* Canadian Ministry of State for Urban Affairs: Ottawa. An earlier study was: Ira M. Robinson (1962) *New Industrial Towns on Canada's Resource Frontier* Dept. of Geography, University of Chicago: Chicago.

APPENDIX SIX

RECREATION

RECREATION: POSITIVE AND NEGATIVE EFFECTS

1.0 INTRODUCTION

This appendix discusses the recreational aspects of the proposed Alameda and Rafferty Reservoirs. The positive and negative effects of reservoirs on recreational activities are first discussed in a general way, then with specific reference to the two proposed reservoirs. The opportunities created by the reservoirs are a function of (a) the physical characteristics of the reservoirs, (b) the supply and demand for reservoir-based recreation in southeastern Saskatchewan, and (c) the steps to be taken to develop and enhance recreational use of the two lakes.

The final section concludes with a summary of specific costs and benefits to outdoor recreation with specific references to the fishing resource, wildlife and general recreation.

2.0 PHYSICAL CHARACTERISTICS

2.1 Rafferty

The potential for recreation development on the reservoir will depend on the shoreline profile and on the reservoir depth. Shorelines must allow easy access to the water, not be overly steep and be resistant to erosion. They must also be irregular in order to create aesthetic interest. Reservoir depth must be sufficient to allow for consistant water quality, temperature stratification and protection from fish winter-kill.

The shoreline will be straight and regular, generally, but interrupted every few kilometres by side entry stream valleys. These valleys, where flooded, will provide embayments providing shelter and interest to lake users.

Backshore and foreshore slopes are likely to have slopes sufficiently steep to provide good drainage and views, but not to preclude access or development where desireable. Because of the slope of the valley walls, the horizontal expression of changes in water level through drawdown will be much less than for reservoirs in flat terrain.

With a size of 4,545 hectares, Rafferty Reservoir will be the third largest artificial impoundment in Saskatchewan. It will be about one-tenth the size of Lake Diefenbaker (43,700 hectares) and nearly one-sixth the size of Tobin Lake (30,365 hectares). It will also be about three and one-half times the size of Blackstrap Lake (1,225 hectares).

Within the Souris Basin, the Rafferty Reservoir will be the largest water body, as it will be about five times the size of Kenosee and White Bear Lakes (See Table 1). These are currently the two largest and most intensively used recreational lakes within the Basin. For further perspective, the Rafferty Reservoir will be about seven and one-half times the size of the Boundary Dam Reservoir.

At the lower end of the reservoir, at full supply level (FSL) waters will rise to within 10 metres from the top of the valley wall. At the upper end of the lake, the backshore will normally rise 15 to 22 metres above water level.

2.2 Alameda

The Alameda Reservoir will be smaller, deeper and narrower than the Rafferty Reservoir. At 1,340 hectares, it will be nearly one-third the size of Rafferty. However, it will have a maximum depth of 24 metres (79 feet) above the dam at FSL.

The lake created by the impoundment of Moose Mountain Creek will be the second largest in the basin, still somewhat larger than Kenosee or White Bear Lakes, and about twice the size of the Boundary Dam Reservoir.

TABLE 1

COMPARISON OF EXISTING LAKES AND PROPOSED RESERVOIRS

SOURIS BASIN IN SASKATCHEWAN

Lake	Size Ha	Development Index(1)	Distance from Urban Centre (km)		
			Estevan	Weyburn	Regina
Existing					
1. White Bear	870	100.3	135	135	200
2. Kenosee	835	92.0	135	140	200
3. Boundary Dam	600	16.3	15	95	215
4. Moose Mountain	525	0	80	80	125
5. Nickle	445	21.7	75	15	120
6. Little Kenosee	180	0	140	140	205
7. Cannington	160	0	145	145	210
TOTALS	3,615				
PROPOSED					
1. Rafferty	4,545		15 (lower end)	40 (upper end)	150 (upper end)
2. Alameda	1,340		60 (lower end)	150 (lower end)	265 (lower end)
	5,885				
TOTAL/BASIN	9,260				

1. Defined as number of cottage equivalent units per 100 hectares (regional park or Saskatchewan Parks and Renewable Resources recreation site assumed to be 50 equivalent units, Provincial Park, 100 equivalent units).

3.0 RECREATIONAL BENEFITS AND COSTS OF RESERVOIR DEVELOPMENT: GENERAL OVERVIEW

3.1 Introduction

A fairly substantial amount of literature exists on the recreational benefits arising from reservoir development. A common theme is the effect on fish and wildlife resources and hence their recreational use.

3.2 Fisheries Resources

Barica points out that reservoirs enhance sport and commercial fishing opportunities in a region. "In general, fish production is expected to increase significantly in the new reservoir and new fish species can be introduced and properly managed to enhance sport and commercial fisheries and tourism", (Barica, 1979, p. 54).

Normal operating depths in both reservoirs will be more than sufficient to ensure over-wintering of fish, according to the criterion indicated. Maintaining sufficient depth to avoid winter-kill will be a fundamental objective of the operating plan for each reservoir. Several aeration techniques are available to provide sufficient oxygen during either winter or summer, and these are discussed in Barica's paper as well (p. 63).

Existing Saskatchewan reservoirs have demonstrated great productivity for fish. A case in point is Tobin Lake, created by the Squaw Rapids Dam on the North Saskatchewan River below Nipawin. The lake is said to provide one of the best sports fisheries in southern Saskatchewan.

In 1980, over 200,000 angler days, nearly ten per cent of the total angler days in Saskatchewan, were expended at Tobin Lake alone. The lake is well-known both for trophy fish and for high fishing success. The productivity of the lake is related to extensive shallow spawning areas, abundant supply of food and varied bottom profile.

Lake Diefenbaker supports a solid commercial fishery of whitefish, in addition to a sport fishery. Lake of the Prairies was created above the Shell Mouth Dam on the upper Assiniboine along the Saskatchewan/Manitoba border for the purpose of flood control, flow augmentation and recreation. It too is a well-known and popular fishing spot. Assessippi Provincial Park on the lower reaches of the lake records about 80,000 visitor days annually, although not all are for the purposes of angling.

One of the major ecological issues associated with dam construction is the interruption of fish migration patterns.

3.3 Upper Missouri Reservoirs

Six Missouri River 'main stem' reservoirs are located in Montana, North and South Dakota. These reservoirs have created very significant recreational benefits, which are described below. The reservoirs, Fort Peck, Lake Sakakawea, Lake Oahe, Lake Sharpe, Lake Francis Case and Lewis and Clark Lake:

" Provided outstanding opportunities for boating, fishing, swimming, camping and enjoyment of other outdoor recreational pursuits. Initial construction of recreational facilities began in the 50's and the Corps and the respective states have continued to provide additional facilities through the years. Visitor use at these Corps lakes has increased almost annually with a dramatic increase noted when normal operating levels were achieved in 1967. Visitor attendance has averaged near ten million visitor days since 1976 ....."

" The recreational activity mixes at these lakes are many and varied. Some persons are just travelling through ..... However, the greatest number of persons visiting these lakes are those who come to fish. It has been suggested that the gigantic Missouri River reservoir system may provide the best walleye fishing anywhere. The visitor attendance closely correlates with fishing success and the walleye is the attention-getter fish. The state of South Dakota boasts of being the walleye capital of the world which attracts many out of state fishermen that no longer take annual fishing trips to Minnesota and Canada. They fish the lake on the Missouri River instead."

" In South Dakota where four of the six lakes are located, tourism has become one of the major industries. What about the influence in North Dakota? Angling pressure has been increased as the word spreads and it will probably continue as long as quality fishing continues. An important management goal is to maintain the excellent walleye fishing, but other species including cool water species such as northern pike, muskellunge, cold water species such as chinook salmon, lake trout, and rainbow and brown trout are also an important part of the long-term reservoir fisheries management plan." (Sveyn and Patenode, in Green and Riker, 1983, p. 102).

With respect to the impact of these reservoirs on tourism:

> "Other than the Black Hills, there is no other state feature with the tourist drawing power of the main stem reservoirs. The State of North Dakota has no other single resource with tourist drawing interest as Lake Sakakowea and Lake Oahe. Considering the boating, fishing, transportation, food and lodging expenditures that go with the ten million annual visitation, there is little doubt as to the tourist value of the main stem." (Sveyn and Patenode, in Green and Eiker, 1983, pp. 105 and 106).

To provide some additional perspective, the primary purposes of this system is to provide flood control and hydropower. Other purposes are irrigation, navigation, and thermal generation (cooling). The recreation benefits described above have been achieved despite periodic or seasonal fluctations in water elevation induced by releases for flood control or hydropower generation.

3.4 Lake Sharpe: Pre- and Post-Impoundment Effects

With respect to both fisheries and wildlife resources, a study of the Lake Sharpe impoundment on the Missouri River in South Dakota (Martin, et al, 1977) shows some interesting comparisons between the pre- and post-impoundment conditions. The study illustrates the following comparisons:

a) An increase of about 80 per cent in migratory goose utilization of the entire chain; after the creation of the Lake Sharpe impoundment;

b) an increased use of the reservoir chain by ducks of over 70 per cent in the decade following impoundment as compared to the pre-impoundment decade;

c) considerably greater hunting activity and dramatically greater hunter success for waterfowl than had been expected;

d) increased hunting activity for white tailed deer, and considerably increased success in the general area, although not necessarily the project lands;

e) loss of habitat and populations for a number of species of upland game birds;

f) development of an excellent pike/walleye sports fishery without overt management assistance; and

g) failure of an anticipated rainbow trout fishery.

This pre- and post-impoundment case study illustrates the potential effect of reservoir development on the fish and wildlife resource, and hence on the recreational use of these resources:

1) loss of habitat for big game species;

2) loss of habitat for upland game birds;

3) creation of new habitat and staging grounds for waterfowl;

4) enhancement of the fisheries resource.

3.5 Summary

The following quote identifies the effects of dams on rivers and on recreational resources:

> " The 'bottom line' is that man-made reservoirs are different ecosystems than the free flowing rivers they replaced, with different potential uses by man and with their own set of environmental problems. Competing and conflicting land-use and water-use issues now move to the front of the line. The decision-maker is faced with loss of terrestrial-based land use and free flowing river use, balanced against a newly created reservoir with a new set of potential land and water uses. Major changes in resource use that can occur when a river changes to a reservoir include an increase in shoreline habitation, loss of white water recreation, increase in pleasure boating and water skiing, and a change in the type of recreational or commercial fishery." (Hildebrand, 1979, p. 323).

4.0 RECREATION SUPPLY AND DEMAND: THE RESERVOIR AREA

4.1 Introduction

The extent to which recreational opportunities will be enhanced depends on the demand for outdoor, water-based recreation, the inherent suitability of the reservoir for recreation and the presence of competing opportunities. This section outlines some of the factors affecting demand, along with supply considerations.

4.2 Population

The population within the 80 km (50 mile) and 160 km (100 mile) radii of each of the reservoirs was determined as an indicator of possible regional market potential for recreational opportunities. Because the reservoirs are located near provincial and national borders, their 'market areas' extend well into Manitoba, North Dakota and Montana.

The population for each of the two zones is shown in Table 2.

It should be pointed out that the two reservoirs are well within 80 km of each other, thereby creating overlap in their market areas. However, an arbitrary 'breaking point' was defined between the two population sheds. The categories for each reservoir's market areas are thus initially exclusive.

There is a population of 66,600 within 80 km of the two reservoirs. About two-thirds of that population is located closer to Rafferty than to Alameda. About one-third of the total population within the 80 km zone is accounted for by the cities of Estevan and Weyburn with a combined population of 21,000. Both are located within 40 kilometres (25 miles) of Rafferty. Consequently Rafferty reservoir is closer to the concentration of demand for recreation opportunities.

TABLE 2

POTENTIAL MARKET POPULATIONS

	Sask.	North Dakota	Manitoba	Montana	Total
		(000)			
A. 0-80 km Zone					
Rafferty	36.0	6.5	—	—	42.5
Alameda	17.0	5.6	1.5	—	24.1
Sub-Totals	53.0	12.1	1.5	—	66.6
B. 80-160 km Zone					
Rafferty	206.0	19.5	—	5.0	230.5
Alameda	20.0	68.5	27.5	—	116.0
Sub-Totals	226.0	88.0	27.5	5.0	346.5
C. TOTALS:	279.0	100.1	29.0	5.0	413.1

The 80 to 160 kilometre zone contains a population of nearly 350,000 over half of which is accounted for by the inclusion of Regina and satellite communities nearly 160 kilometres to the northwest of Rafferty Reservoir. Alameda's potential market area, on the other hand, includes a sizeable population in adjacent North Dakota. Ward County, including the City of Minot, with a population approaching 50,000, lies within 160 kilometres to the south of the proposed Alameda Reservoir. The Rafferty reservoir is only slightly further away.

In total, a population of greater than 400,000 lies within one hundred and sixty kms of the Rafferty or Alameda Reservoirs. This population represents a fairly significant base which would be within two hours drive from either reservoir. Consequently, there appears to be more than an adequate population base to enjoy recreational benefits if the reservoirs are capable of offering a range and variety of opportunities.

Significantly, over one hundred thousand or nearly one-third of the population within 160 kilometres is located out of Saskatchewan, the majority from North Dakota. Any visitations to either reservoir from North Dakota would represent not only the creation of a recreation benefit, but also the export of a tourism product from Canada. The observations in Section 3.3 that Americans, especially Dakotans, find their quality fishing near home, on the Missouri, is significant in this respect. If an attractive alternative can be created near the Dakotas, then the opportunity may exist to divert at least a modest proportion of that angling demand to the Alameda and Rafferty Reservoirs.

4.3 Preferences in Outdoor Recreation

Data on preferences or participation in outdoor recreation in Saskatchewan are, unfortunately, both inadequate and somewhat out of date. However, data on participation rates for the Souris

Basin in Manitoba may provide some indication of recreational preferences within the potential market area of the two reservoirs. This assumes that the lifestyle, age, income and other patterns affecting recreational participation are similar on either side of the Manitoba/Saskatchewan border. This seems not an unreasonable assumption. The results are shown in Table 3.

It is significant that of the ten most popular activities, three, swimming, fishing, and motor boating, are water based activities. Three others, cottaging, camping, and picnicking, are water related, as virtually all cottages, most campgrounds and many picnic areas occupy lakeshore locations. The most popular activity, recreational driving, would be encouraged or enhanced, it is fair to assume, by the presence of water bodies as destination or pass-by attractions. Without referring to any specific studies, the presence of water bodies in the landscape provides visual interest, contrast and relief from the monotony of the prairie landscape.

4.4 Supply of Water-Based Recreational Opportunities

The Souris Basin in Saskatchewan near Estevan and Weyburn is very poorly provided with water bodies providing opportunities for recreational activities. Boundary Dam on Long Creek near Estevan, Nickle Lake on the Souris River near Weyburn, and the Souris River are virtually the only water bodies in the immediate area. The Moose Mountain upland, some 145 kilometres (90 miles) to the northeast of Estevan has two highly developed recreational lakes, Kenosee and White Bear (Carlyle), and several less developed smaller lakes. Moose Mountain Provincial Park is the most heavily used provincial park in Saskatchewan.

TABLE 3

OUTDOOR RECREATION PARTICIPATION RATES
SOURIS BASIN IN MANITOBA, 1976

Activity	Participation Rate: Per Cent of Total Population	Number of Participant Days
		(000's)
1. Recreational Driving	67.0	491.5
2. Swimming	52.8	450.3
3. Visiting Cottages	41.0	337.6
4. Camping	41.1	310.7
5. Recreational Bicycling	27.1	302.5
6. Fishing	38.2	291.4
7. Recreational Snowmobiling	23.5	267.0
8. Golfing	24.3	221.3
9. Motorboating	32.8	213.4
10. Picnicking	42.1	158.1
11. Waterskiing	14.6	78.0
12. Tennis	12.4	71.7
13. Canoeing	17.9	69.1
14. Recreational Horseback Riding	9.6	61.2
15. Tobogganing or Sledding	13.3	59.4
16. Walking, Unguided Nature Trails	18.0	59.1
17. Visiting History or Nature Exhibits	28.1	55.2
18. Ice Fishing	10.1	49.7
19. Hiking	13.0	48.9
20. Recreational Trail Biking	4.3	48.7

Less than 45,000 participant days (in descending order of frequency): downhill skiing, visiting historic sites, row boating, sailing, snowshoeing, walking on guided nature trails.

Source: Souris River Basin Study, 1978. Supplement 5, Water Related Resources, Volume 2R. The Need and Associated Benefits of Recreation in the Souris River Basin, 1976-2027.

Problems with fluctuating water levels, declining fish stocks and overcrowding suggest a need for alternatives to the Moose Mountain Lakes (Christiansen, 1980).

Cottaging opportunities within the Basin are similarly limited. Boundary Dam Reservoir at Estevan has forty-eight cottages. The only other major cottaging areas are at Moose Mountain. Kenosee Lake has more than 600 cottages, while White Bear has over 900. These two lakes have some of the highest cottaging densities in the province, relative to lake area. The current Saskatchewan Park Masterplan indicates the need for another large provincial park in S.E. Saskatchewan to relieve the pressure in the Moose Mountain Provincial Park area.

The supply of quality fishing is similarly limited. Boundary Dam Reservoir provides perch and walleye, the Souris River provides angling for bullheads, perch and some walleye, but fishing is limited by fluctuating lake levels and low river flows. Nickle Lake and Dead Lake are small reservoirs which attract anglers locally. The opportunity for river fishing in the area is limited.

Opportunities for water contact recreation are limited by water quality problems related to swimmer's itch and algae blooms in the few water bodies present.

4.5 Developed Recreation Areas

Recreation areas developed or supported by the provincial government are as follows:

Regional Parks:

1. Woodlawn, Estevan: campground, golf course, picnic area, pool, sports fields.

2. Nickle Lake, Weyburn: campground, picnic area, boating.

3. Dr. Mainprize, Midale: campground, golf course, picnic area, swimming pool.

4. Oungre Memorial, Oungre: campground, winter recreation, summer swimming pool, golf course.

5. Bow Valley, Oxbow: campground, golf course, picnic area, playgrounds, ball diamonds, boating.

Provincial Recreation Sites:

1. Highways Campgrounds and/or Picnic Sites at: Griffin, Macoun, Roche Percee, Souris River (near Northgate), Boundary Dam.

Provincial Historic Parks:

1. Cannington Manor Provincial Park (northeast of Carlyle).

Moose Mountain Provincial Park:

Extensive wooded upland areas, 40,000 hectares in size, a number of small lakes. Kenosee Lake is focus of recreational activity. About 145 kilometres from Estevan and Weyburn, about 80 kilometres from Oxbow. Over 600,000 visitor trips in 1986.

4.6 Recreation Opportunities: Adjacent Areas

Just to the north of the 160 km zone lie the seven lakes of the Qu'Appelle chain. Because of proximity to Regina and Moose Jaw, these have experienced very substantial development. With the exception of Buffalo Pound and Last Mountain Lake, there appear to be few additional opportunities for supplementary, more intensive development of these lakes, without compromising the quality of the outdoor recreational experience. Thus, the creation of the Rafferty and Alameda Reservoirs would add to the range of recreational options available within a two hour drive, in the case of Rafferty Reservoir, and a three hour drive, in the case of Alameda, from Regina.

4.7 Provincial Trends

Saskatchewan residents are showing an increasing interest in angling as a recreational pastime. From 1981 to 1985, the number of angling licenses sold increased from 200,000 to 250,000 (Philips, 1987). While Saskatchewan has 94,000 lakes, most are in the north. The majority of people live in the south. Increasing pressure on what is a finite resource has led fishery managers to adopt enhancement measures: rearing ponds, increased stocking, experimentation with new species. Within this provincial context, the creation of two new water bodies with potential to create a sports fishery is especially significant.

Saskatchewan residents also show an affinity for the cottage at 'the lake' which is greater than for Canadians as a whole. For example, according to one source, in 1976, 'visiting cottages' involved nearly twice as many participants in Saskatchewan, as in Alberta. The number of participant days was nearly equal despite the fact that Alberta had twice the population of Saskatchewan. Further, Saskatchewan had sixty per cent more participation days for cottaging than Manitoba. (PFWB, 1982, p. 99).

Currently there are more than 25,000 cottages in Saskatchewan. A recent study (Report of the Working Committee on Resort Communities, 1986) predicts that this number will double within the next fifteen years. The prediction is based on past trends and preferences, on the demographic phenomenon of the 'baby boom' generation moving into middle age and on other factors. With many popular lakes reaching a saturation point in terms of cottaging (e.g., Christopher/Emma, Kenosee, the Qu'Appelle Lakes), the questions arise as to where new cottaging areas will be located. Certainly, the creation of two new water bodies would help satisfy demand and divert pressure from other lakes in south-eastern Saskatchewan.

Cottaging demand in Saskatchewan emanates from both large and small urban communities as well as the rural communities. For example, sixteen of the cottages at Kenosee Lake are owned by residents of Alameda which has no more than 140 households. Therefore, it would be a mistake to view cottaging demand as if it originates only from the larger urban centres.

4.8 Conclusions

Southeastern Saskatchewan is deficient in resources supplying water based recreational opportunities. Existing resources, especially those in Moose Mountain, are over used. Demand for fishing and cottaging is growing and the issue of supplying this demand is being addressed at the provincial level. The creation of two new water bodies would certainly redress the imbalance between the populated areas of the province and the supply of water based recreational opportunities.

5.0 RECREATIONAL COSTS AND BENEFITS

5.1 Introduction

This section presents further details regarding the positive and negative impacts to outdoor recreation and tourism arising from the development of the Rafferty and Alameda reservoirs.

5.2 Effects

A number of significant positive effects are anticipated. These are discussed below:

1. Reservoir development would result in a tremendous enhancement of water-based outdoor recreation resource in south-eastern Saskatchewan.

   The water area suitable for water-based recreation within the Souris Basin would increase by 275 per cent, as shown in Table 1.

   This constitutes a very significant enhancement of recreational resources for the more popular water-based recreational activities of angling, swimming, boating and water skiing, as well as for water-related activities such as cottaging, picnicking or viewing of wildlife.

2. This increase in recreation resource is especially important in an area and a province where the most abundant water resources are located in areas of low population density, while the settled areas experience a deficiency of water resources suitable for recreation.

There is an undersupply of water bodies of moderate to high recreation capability within the Souris Basin and within the outdoor recreation market areas of Regina and Moose Jaw.

3. The development of Rafferty and Alameda reservoirs will avoid substantial costs which would be incurred through overdevelopment and overcrowding of existing recreation areas, such as Kenosee Lake or the Qu'Appelle Lakes, by providing alternative opportunities for water-based recreation. Further recreational development of these existing lakes could lead to loss of recreational enjoyment, expensive lake management approaches, such as water diversion, and environmental deterioration resulting from overuse.

4. A significant increase in recreational opportunities will be experienced by the residents of the Souris Basin and surrounding areas.

5. Development of the two reservoirs and the downstream Souris River would enhance the province's fishery resource and assist in supplying the growing demand for sport fishing.

6. The creation of the two reservoirs near the international border, within 160 km of a population of 100,000 within North Dakota and Montana would invite considerable participation by Americans in a variety of recreational opportunities. This would represent export of tourism services.

7. By creating two reservoirs and promoting them in conjunction with existing regional tourism attractions such as Moose Mountain Provincial Park and Cannington Manor Provincial Historic Park, the total tourism package offered in the

southeast would be very substantially enhanced. Simply put, there would be twice as many reasons to visit southeastern Saskatchewan.

8. Improved waterfowl hunting opportunities.

9. Improved private investment opportunities for associated tourism industry. (rental accommodation, boat sales and services, etc.).

10. Improved business opportunities for existing private enterprises (motels, restaurants, gas stations, etc.)

Negative effects arising from the creation of the reservoirs include:

1. Flooding of Dr. Mainprize Regional Park, ($600,000) and the Lutheran Bible Camp ($260,000) along with subsequent loss of recreational opportunities and with costs of compensation or replacement.

2. Loss of some wildlife and wildlife habitat in the areas to be flooded and loss of associated recreational opportunities for hunting and wildlife appreciation of certain species (viewing, photography, etc.).

3. Capital and annual operating costs of enhancement measures to achieve the possible recreational use.

5.3 Specific Benefits and Costs

5.3.1 Angling

It is felt that one key to developing the recreational resources of the reservoirs is to create a productive sport fishery. Earlier reports were somewhat conservative in estimating the net increase in resource productivity. The WRC (1985) report mentioned the negative effect on spawning areas and risk of extensive winterkill at times of low water levels. Benefits were included in general recreation benefits.

Background studies, Souris Basin Development Authority, (1986) report pointed out that, regionally, the demand for sport fish far exceeds the supply. While some loss of spawning grounds was anticipated, opportunities to provide additional habitat would be created for Rafferty. For Alameda, a positive effect on fish habitat with a net gain in spawning areas was anticipated.

Annual angling benefits of $1.2 million for Rafferty and $530,000 for Alameda were suggested after successful establishment of the sport fishery. These figures were based upon comparison with Lake of the Prairies, the impoundment on the Assiniboine River created by the Shellmouth Dam. The above values are not included directly in the benefit cost formulations but are included with the increased recreational days which are in the analysis.

Costs which were identified include tree and brush clearing, fisheries enhancement programs and the creation of artificial spawning areas.

The Department of Saskatchewan Parks and Renewable Resources (SPRR) (Fisheries Branch) has been very positive about fishery enhancement opportunities in both lakes. An increase in perch, pike, and walleye populations in both lakes is anticipated. The possibility of introducing other species, such as rainbow trout in Rafferty and lake trout in Alameda has been mentioned as adding to the variety of angling opportunities. The advisability of developing rearing ponds for Rafferty, to facilitate early establishment of walleye (the most popular sport fish) populations was identified.

The following benefits and costs were used as part of this analysis:

Benefits:

1. Recreation user-days were increased for general recreation on the assumption that a productive sport fishery would be developed on both lakes and downstream on the Souris River, and that this would be reflected in higher user response than earlier anticipated. This requires an operational plan which incorporates water level requirements for spawning.

Capital Costs:

1. Cost of developing a rearing pond - $350,000. This was based on the cost of rearing ponds built at Codette Reservoir, Jackfish Murray Lake and a cost estimate for rearing ponds in the Qu-Appelle system. Information was supplied by Fisheries Enhancement programs for Saskatchewan Parks and Renewable Resources.
2. Costs of habitat enhancement within the reservoirs is estimated at $105,000.
3. Additional non specific fish enhancement costs are $150,000.

Annual Costs:

1. Fisheries enhancement and monitoring program costs of $21,000, primarily staffing, operations and cost of fry for rearing pond at Rafferty.

5.3.2 Wildlife

Both positive and negative effects will be experienced as a result of the two reservoirs.

The WRC (1985, pp. 80-82) report identified the following negative effects or costs:

1. Loss of 6,220 ha of wildlife habitat at Rafferty and 2,130 ha at Alameda, much of which is designated as critical wildlife habitat under the provincial government's Critical Wildlife Habitat Protection Act.

2. The loss of waterfowl production areas along the Souris River and Moose Mountain Creek.

3. The loss of the harvestable surplus of game and fur-bearing animals, valued at $130,000 annually, including hunting opportunities, meat and recreational opportunities.

.4 The loss of non-consumptive use opportunities valued at $70,000.

The one benefit identified in the WRC report was:

1. Increased waterfowl hunting opportunities valued at $60,000, (1,300 days @ $45.00).

Subsequent relocation of the Rafferty Dam further downstream and a lowering of the FSL by two metres has resulted in a considerable saving of critical wildlife habitat. Whereas 6220 ha of habitat loss was anticipated by WRC in 1985, the reservoir area at FSL is now 4545 ha. The critical wildlife habitat loss has been reduced accordingly. The critical wildlife habitat loss at the Alameda Reservoir will be 1350 ha at FSL.

In addition to the reduced wildlife habitat losses at the lower FSL at Rafferty, a number of mitigation measures are proposed which will further reduce the negative impacts of the project. Because of the lower FSL and the proposed mitigation measures, the "wildlife costs" outlined by WRC were greatly overstated and have not been directly used in this study.

In addition a number of significant waterfowl enhancement opportunities have been identified, namely, the creation of a waterfowl refuge in the upper Dead Lake channel northwest of Dr. Mainprize Park and in the upper reaches of the reservoir north and south of Grid #705 and the setting aside of many islands within the reservoirs as wildlife refuges. These enhancement measures would create significant opportunities for nesting, rearing and staging of waterfowl, enhance appreciative, wildlife-related recreation such as viewing and photography and enhanced hunting opportunities. The result is a significant increase in visitor days.

As a result, the statement of costs and benefits prepared by WRC (1985) has been modified by the addition of various mitigation and enhancement projects with a significant addition of non-consumptive benefits over those previously determined. Capital costs for wildlife mitigation and enhancement are estimated to be $2,102,000. Further allowances have been made for short term operation maintenance and research of $937,500, and, a depredation fund of $750,000.

5.3.3 General Recreation

The WRC (1985) report makes two important points:

1. Considerable enhancement will be required to realize the maximum recreation benefits of both reservoirs, and

2. A relatively stable water level, especially during the summer season will be required to maximize recreational benefits. Otherwise, capital costs on docks and marinas would be higher, to accommodate fluctuations and lower recreational participation might be anticipated, reducing recreational benefits.

A program for recreational development of both reservoirs was prepared, based both on anticipated market requirements and on the inherent resource capability of the water bodies.

Development and Ongoing Costs

The basic components of the development program with capital and annual costs are as follows: (See Outdoor Recreation Enhancement Section of the EIS for more detail)

1. Replacement and enhancement of Dr. Mainprize Regional Park

Total Capital	$1,520,000
Annual operations and maintenance @ 15%	210,000
The current Dr. Mainprize facilities will require annual operation and maintenance if the reservoir is not created. As the facilities are nearing the end of their life cycle, the 15% of present worth allowance is a very conservative estimate of the cost of maintaining the facilities in their current state. The displaced annual operations and maintenance costs are $90,000 (600,000 x .15). Net increase in annual operation and maintenance is $138,000. Ten year maintenance development trust fund provided by SBDA.	200,000

2. New Recreation Area on Lower Rafferty

Total Capital	2,690,000
Annual operations and maintenance @ 15%	403,500

3. New Recreation Area on Alameda

Total Capital	1,200,000
Annual operations and maintenance @ 15%	180,000

4. Rafferty Cottages

Capital Service Costs:	$1,225,000

Rafferty: Cottaging areas. These would be distributed between the relocated 'Dr. Mainprize' site and the 'Lower' site. Considering demands from Estevan, Weyburn, Regina and local communities, 175 cottages are envisioned.

175 cottages (125 lower Rafferty, 50 Dr. Mainprize) with servicing costs of $7,000 per lot, including on and off site services.

NOTE: The $7,000 is categorized as follows:

Sewer Collection	1,500
Sewer Disposal	1,500
Water System Storage and Treatment	2,000
Roads and Drainage	1,000
Surveying, Planning and Engineering	500
Power	500
TOTAL	$7,000

5. Alameda Cottages

Capital Service Costs:	700,000

Alameda: Cottaging areas. Considering demands from local communities, Estevan and the U.S., 100 cottages are envisioned.

100 cottages, with servicing costs of $7,000 per lot, including on and off-site services.

Benefits of New Recreational and Wildlife Opportunities

Given the previous discussion of the supply/demand situation for water-based recreational opportunities in southeastern Saskatchewan, the magnitude of enhancement measures and the assumed creation of a viable sports fishery, it is predicted that recreational usage of the reservoirs will be higher than originally envisioned in the WRC (1985) report.

All recreational and wildlife enhancement benefits are measured by the increase in visitor days. Estimated visitation levels at full development in 15 years and the value of these opportunities at $21 per day are estimated as follows: (see Annex for derivation of $21 value of outdoor recreation and see Outdoor Recreation Enhancement EIS, for visitor day estimates)

Dr. Mainprize Park

Lost visitor days	25,000	
New visitor days	80,000	
Net gain visitor days	55,000	
Benefits (annual):		$1,155,000

Lower Rafferty Park

Visitor days	120,000	
Benefits (annual):		2,520,000

Alameda Park

Visitor days	70,000	
Benefits (annual):		1,470,000

Dr. Mainprize Cottages

Visitor days (50 cottages occupied 72 days per year with party size of 4.2)	15,000	
Benefits (annual):		315,000

Lower Rafferty Cottages

Visitor days (125 cottages)	37,500	
Benefits (annual):		787,500

Alameda Cottages

Visitor days (100 cottages)	30,000	
Benefits (annual)		630,000

Hunting

Lost hunting due loss habitat Visitor days	6,000	
New hunting opportunities Visitor days	9,000	
Net gain hunting opportunities Visitor days	3,000	
Benefits (annual):		63,000

The net gain represents a shift from big game to waterfowl because of potential loss of habitat

Non-Consumptive Use (joyriding, sightseeing)

Lost visitor days	3,500	
New visitor days	5,000	
Net gain visitor days	1,500	
Benefits (annual):		31,500

This is a conservative estimate in light of the viewer facilities to be established at the dam site during construction.

5.4 Summary

The values of costs and benefits are summarized in Table 4.

TABLE 4

SUMMARY: RECREATIONAL COSTS AND DIRECT BENEFITS

RAFFERTY-ALAMEDA RESERVOIRS

		Capital Costs	Annual Costs	Benefits
A.	Sport Fishing			
1.	Enhancement Cost: Walleye - Rearing Ponds, Annual Operations	$ 650,000	$ 21,000	
2.	Increased Recreational Participation			Included in increased Participation for General Recreation
B.	Wildlife			
1.	Gain in Non-Consumptive Use Opportunities		$ 31,500	
2.	Wildlife Enhancement, Dr.Mainprize, East Channel	$2,102,000	$ 15,000	
3.	Short Term Operation and Maintenance and Research	$ 937,500		
4.	Depredation prevention fund	$ 750,000		
5.	Increased Hunting Opportunities			$ 63,000
6.	Increase of Non-consumptive Use Opportunities			$ 31,500
C.	General Recreation			
1.	Replacement of Dr. Mainprize, Regional Park	$ 600,000		
2a	Enhancement of Dr. Mainprize, Regional Park Operations at 15%	$ 920,000	$ 138,000	
2b	Development trust fund	$ 200,000		

		Capital Costs	Annual Costs	Benefits
3.	Enhanced Use of New Dr. Mainprize, 75,000 days at $21			$ 1,155,000
4.	Cost of Cottaging Development, Dr. Mainprize Operation at 3%	$1,850,000	$ 55,000	
5.	Recreational Use of Dr. Mainprize Cottages			315,000
6.	Cost of Lower Rafferty Park Operations at 15%	$2,690,000	$ 403,500	
7.	Cost of Cottaging Development, Lower Rafferty Operation at 3%	$4,625,000	$ 138,750	
8.	Recreational Use of Lower Rafferty Park			$ 2,520,000
9.	Recreational Use of Rafferty Cottages			$ 787,500
10.	Cost of Alameda Park Operations at 15%	$1,200,000	$ 180,000	
11.	Cost of Alameda Cottaging Operations at 3%	$3,700,000	$ 111,000	
12.	Recreational Use of Alameda Park			$ 1,470,000
13.	Recreational Use of Alameda Cottages			$ 630,000

* Values used in the WRC (1985) Report.

6.0 CONCLUSIONS RECREATION

Man-made reservoirs are different ecosystems from the free flowing rivers they replace. Also Souris River flows become so low during the summer months that recreational facility development is difficult. As a consequence the new reservoirs will not only change the type of recreational opportunities, they will change the amount (people participation) of potential activities.

Southeastern Saskatchewan is deficient in water based reacreational facilities. Existing facilities, particularly in Moose Mountain, are overused. Long-term plans call for the development of two new facilities in this region to offset the current recreation pressure and to facilitate the growing demand for cottaging and other recreational facilities. The U.S.A. has already developed their water resources south of Saskatchewan to make maximum use of local recreational potential. This investment has paid off with the establishment of a national reputation for their walleye fishery accompanied by a significant increase in tourist trade.

The creation of two reservoirs (Rafferty and Alameda) will increase the water surface area within the Souris Basin in Saskatchewan in excess of one and one-half times. This represents a significant opportunity to develop water based recreational facilities to meet the current excess demand. The recreational losses because of the projects are relatively minimal. The facilities at Dr. Mainprize and the Lutheran Bible Camp are reaching the end of their respective life cycles and recreational attendance is dropping. With the pent up demand for improved recreational facilities and for cottaging opportunities, the reservoirs represent increased recreational opportunities.

Hunting experiences around Lake Sharpe in the U.S.A. indicate increased hunting scope, albeit a shift from big game to waterfowl hunting. The issue of lost nonconsumptive use opportunities i.e. sightseeing, etc. because of the reservoirs has been addressed in previous studies. With the occasions being provided for sightseeing facilities during dam construction and with the extensive park and cottage developments, sightseeing opportunities will increase significantly around the reservoirs.

In a region with overcrowded recreation facilities and limited fishing scope, and with a growing demand for water oriented recreation, the Rafferty/Alameda reservoirs will provide for significant increases in recreational opportunities.

ANNEX 1: THE VALUE OF OUTDOOR RECREATION

A limited number of measures of value are available to reflect the economic contribution of outdoor recreation. Expenditures per visitor day for various activities, sales of recreational equipment, employment in recreation and revenue from the sale of hunting or fishing licenses have all been used as economic indicators of recreation.

The value of a recreation day is composed of the amount a participant is paying for the experience and the amount that same activity is worth to the participant. It is important to note that his willingness to pay must represent the same level of activity that he is currently using, and not his willingness to pay for the last unit of recreation before he gives up the activity altogether because of high costs. Obviously the worth of the recreational experience will be greater than or equal to the actual costs or the individual would not participate.

Recreation Expenditures

Recreation expenditures per visitor day within the Souris Basin were estimated in Souris River Basin Study (SRBS) to be $2.74 per day user and $3.25 per camper per day in 1977 dollars. More recent studies of actual expenditure patterns of campers, cottagers and day users for two provincial parks on Lake Diefenbaker have been conducted (O'Grady, Kulshreshtha, Brockman, 1986). The above study encompassed all provincial recreational sites within the South Saskatchewan River Basin in Saskatchewan. The two sites (Danielson and Douglas) were chosen as the most comparable to the recreation areas that would be established on the Rafferty and Alameda reservoirs.

Expenditure patterns for Danielson were $13.40 per visitor day and for Douglas were $11.40. The midpoint value of $12.40 was taken as the appropriate daily value. If the cash expenditures reported in the

SRBS are inflated by the consumer price index to 1986 dollar values, recreation expenditures are estimated at $5.34 and $6.33 for day use and overnight use respectively. This discrepancy demonstrates increasing expenditure patterns for local outdoor recreation greater than the consumer price index.

The above estimates are for cash expenditures only. The allocation of capital overhead costs for recreation equipment per user day is also an essential component of the cost of recreation expenditures. The value of recreational equipment per visitor averaged $2,428 for all provincial recreational sites in the South Saskatchewan Recreation Study (1986). This capital value was divided by the number of recreational activity days per year and by the life expectancy of the capital asset for a recreational day cost per visitor of $8.63. The total cost of both cash expenditures and a recreational capital allowance is estimated at $21 per visitor day. The $21 value was used in this study as a basis for establishing secondary benefits arising from recreational expenditures.

Other estimates of recreational expenditures are as follows:

1. The report of 'The Importance of Wildlife to Canadians, Highlights of the 1981 National Survey', (CWS, 1985), etimated the following expenditure patterns:

   a) $37 per day for nonconsumptive use of wildlife across Canada.
   b) $37 per person-day for hunting across Canada and $32 per day in Saskatchewan.

2. A recent article in the Saskatoon Star Phoenix by Wayne Philips quotes SPRR figures of $35 per day for expenditures by anglers.

3. Expenditures by visitors to the Dickson Dam reservoir (Alberta) are estimated at $22 per visitor day. Personal communication Alberta Environment, Planning Division.

Recreation Benefits

The SRBS estimates of recreational benefits are based on a study conducted for the Canadian Wildlife Service by the Institute of Northern Studies on the role of recreational activities in Saskatchewan (1974). A questionnaire was utilized for this study where respondents were asked to estimate the benefit they received from outdoor activities where bird life was present.

Average benefits for several classes of users (urban, rural, casual, intensive) was $15.46 per recreation day (1974 dollar value). Respondents indicated that they would be willing to spend twice this amount rather than forego the recreational opportunity, but caution must be used in utilizing these higher numbers as they will most probably represent a decrease in user activities. Rather than extrapolate a complete demand schedule, the $15.46 value was assumed as the benefit to recreation in excess of recreational expenditures. If the above value is adjusted to 1986 dollars via the CPI the value of a recreation day over and above expenses is $39 per day.

Other estimates of recreational benefits are as follows:

1. The value of $45 per recreation day was used by the WRC (1985) report, for general recreation and for hunting, by updating the values used in the Souris Basin Reports to account for the effects of inflation.

2. "A day of general outdoor recreation has been valued at $30.00. This figure was obtained from the Manitoba Souris Basin reports. Hunting recreation was valued at $25.00 per day." (Souris River Basin Study 1978, Supplement 5, Volume 1-G, p.14).

Net Benefits

Net benefits utilized in the benefit/cost ratio are Recreation Benefits - Recreation Expenditures + entrance camping fees ($39 - 21 + 3 = $21) per visitor day. The entrance camping fees have been added back into the net benefits to avoid double counting this portion of the recreational facilities costs already accounted for in annual operation and maintenance costs for the facilities.

All recreational wildlife benefits are estimated via recreational visits. The logic for this is that the relative value of recreational opportunities will be reflected in active (such as hunting and swimming) and passive (such as sightseeing) visits.

APPENDIX SEVEN

SECONDARY IMPACTS

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SECONDARY IMPACT

Introduction

A change in the expenditure pattern by an economic agent in our society has more far-reaching effects upon the economic well-being of people than is commonly recognized by a casual inspection. Changes such as these affect personal incomes, corporation finances, and government revenues, among others. Not every investment project yields identical impacts upon the economy. Some investments lead to a spur in the economic activity of the region, whereas benefits from others are such that they leak out to people and businesses outside the area of investment. Thus, not all investment projects are equally desirable from regional or provincial development perspectives.

From the standpoint of social desirability of a project, benefits of a project to all economic agents of the society must be considered. The costs of developing a project must, in order to make valid comparisons, be outweighed against benefits to all... those directly affected (benefited) as well as those who are affected through the actions of the former. Thus, it is important to estimate not only the net benefits of those who participate (or are affected by) in a program of investment, but also of those whose economic fortunes may change as a result of decisions taken by the previous group. This is attempted in the context of the Souris River Development in this appendix.

This appendix describes the methodology followed in estimating the impacts of the Souris River Development... that is, development of the Rafferty and Alameda reservoirs and related economic activity as described in the Report.

Estimation of impacts is carried out using the Saskatchewan Input-Out Model, which is briefly described. Estimated impacts are then presented in the last section of this appendix.

ECONOMIC IMPACTS OF A DEVELOPMENT PROJECT

Economic development of a region can be measured in several ways, most common of which is the measurement of aggregate economic activity. This is defined as a sum of returns received by various factors of production in the economy and is termed gross domestic product. In the context of input-output models, this gross domestic product can be broken down into four major components: i) household incomes, which may be obtained from any of the following sources... wages, salaries and supplementary labor income; net income of unincorporated farm and non-farm businesses; interest and other investment incomes; and income from exogenous sources. ii) other operating surplus of incorporated as well as unincorporated businesses, which includes capital cost allowance, as well as sums retained by corporations as profit. iii) indirect taxes, collected by various levels of the governments... federal, provincial, and local, and iv) subsidies, paid by various levels of the government to various industries as well as to groups of individuals.

Contributions of a development project thus can be measured in terms of change (increase or decrease) in the gross domestic product resulting from various activities directly related to the project. A project such as Rafferty and Alameda reservoirs could have several types of impacts upon the regional economy. Notable among these are the following three:

i) Direct Impacts: These impacts result directly from an expenditure related to a project. For example, development of the Rafferty reservoir may involve hiring an engineering firm for designing of the dam, and later on, awarding a contract to a construction company. Both of these, among several others, would constitute direct impacts of a project.

ii) Secondary Impacts: Direct expenditures result in subsequent contributions to the economy through purchases of inputs or through selling their products. For example, a direct expenditure on construction, which may involve buying concrete, would result in more concrete being produced in the region, resulting further in the purchase of cement and gravel (products of quarries) and hiring of more workers to produce the concrete. Similarly, if the reservoir water is used for irrigation, and that leads to cattle feeding in the region, which may increase the meat processing activity, this should also result in higher gross domestic product in the region. These industries in turn will purchase more inputs in order to meet the demand, and a sequence of events would follow, resembling like the "ripples" in a calm body of water created by throwing a stone... each subsequent ripple being of lesser intensity, until the water body attains calmness once again. These impacts are conventionally called "secondary" impacts and can be broken down further into two types of changes:

a) Impacts resulting from backward linkages of one industry with other industries in the region. These linkages are those which are developed as a result of purchases of inputs from other industries, and agents of production.

b) Impacts resulting from forward linkages of one industry with other industries in the region. These linkages are built through purchase of the products produced by one industry by other industries.

Each of the backward and forward linkages impacts could take two alternate sequences: In one sequence an industry would purchase goods and services produced by others. The resulting impacts are called indirect impacts. The second sequence would commence from the above one in that wages paid out to labor are re-spent in the economy on consumer goods and services. This sequence of impacts resulting in higher gross domestic product is called induced impacts. Note, both backward linkages as well as forward linkages impacts would have indirect and induced impacts.

iii) Stemming-from Impacts: In addition to the above impacts, depending upon the nature of the project, and time period under consideration, another impact could be realized. As a consequence of direct impacts, some new industries may move into the region. These industries would purchase inputs from existing industires and would employ workers. Both of these would result in higher economic activity.

The above three types of impacts can be estimated by appropriate tools such as input-output model. In some ways the estimation of these impacts is analogous to capturing external influences of a project.

STUDY METHODOLOGY

Direct and secondary impacts of the Rafferty and Alameda reservoirs are estimated in this report using an input-output model of the Saskatchewan economy. The model is originally based upon 1979 transactions, but was updated to 1984 level of transactions using a non-survey technique. The model is of a medium aggregation (in terms of Statistics Canada specification) with agriculture and agricultural processing sectors further disaggregated. A list of sectors (industries) included in the model is shown in Table 1, whereas the commodities (both intermediate and primary) are in Tables 2 and 3.

Impacts were estimated by including the household expenditures along with inter-industry transaction. Thus, the multiplier matrix so created indicates both indirect and induced impacts of the direct expenditures. In most cases only the backward linkage impacts were estimated; for a selected scenario both backward and forward linkage impacts were estimated. No stemming-from impacts are expected to be realized as a consequence of the Rafferty-Alameda project, on account of its small size. Therefore such impacts are not estimated in this report.

Table 1

LIST OF SECTORS IN THE INPUT-OUTPUT MODEL

No.	Sector Description	No.	Sector Description
01	Dairy Farms	33	Knitting Industries
02	Cattle & Livestock Farms	34	Clothing Industries
03	Hog Farms	35	Wood Industries
04	Poultry Farms	36	Furniture & Fixture Industries
05	Wheat Farms - Brown Soil	37	Paper & Allied Products Inds.
06	Wheat Farms - Dark Brown Soil	38	Printing & Publishing Industries
07	Wheat Farms - Black Soil	39	Primary Metal Industries
08	Other Grain - Brown Soil	40	Metal Fabricating Industries
09	Other Grain - Dark Brown Soil	41	Machinery Industries
10	Other Grain - Black Soil	42	Transportation Equipment Inds.
11	Fruit & Vegetable & Other Farms	43	Electrical Products Industries
12	Intensive Irrigation	44	Non-Metallic Mineral Pdts. Inds.
13	Backflood Irrigation	45	Petroleum & Coal Products Inds.
14	Forestry	46	Chemical & Chemical Pdts. Inds.
15	Fishing/Hunting/Trapping	47	Misc. Manufacturing Industries
16	Metal Mines	48	Construction Industry
17	Mineral Fuels	49	Transportation & Storage
18	Non-Metal Mines and Quarries	50	Communication
19	Services Incidental to Mining	51	Utilities
20	Slaughtering & Meat Processing	52	Wholesale Trade
21	Poultry Processors	53	Retail Trade
22	Dairy Factories	54	Owner Occupied Dwellings
23	Fruit & Vegetable Processing	55	Finance/Insurance/Real Estate
24	Feed Manufacturers	56	Education & Health Services
25	Flour & Breakfast Cereal Inds.	57	Amusement & Recreation Services
26	Bakeries	58	Services to Business Management
27	Vegetable Oil Mills	59	Accommodation & Food Services
28	Misc. Food Manufacturing	60	Other Personal & Misc. Services
29	Soft Drink Manufacturers	61	Transportation Margins
30	Rubber & Plastic Products Inds.	62	Operating/Office/Food/Lab
31	Leather Industries	63	Travel & Advertising Promotion
32	Textile Industries		

Table 2

LIST OF COMMODITIES IN THE INPUT-OUTPUT MODEL

No.	Commodity Description	No.	Commodity Description
01	Wheat	37	Furniture & Fixtures
02	Other Grains	38	Paper & Paper Products
03	Cattle & Calves	39	Printing & Publishing
04	Hogs	40	Primary Metal Products
05	Poultry	41	Metal Fabricated Products
06	Other Live Animals	42	Machinery & Equipment
07	Milk	43	Autos/Trucks/Transport Equipment
08	Eggs	44	Electrical & Communication Pdts.
09	Fruits & Vegetables	45	Non-Metalic Mineral Products
10	Oilseeds/Nuts/Kernels	46	Petroleum & Coal Products
11	Other Agricultural Products	47	Chemicals & Chemical Products
12	Forestry Products	48	Misc. Manufactured Products
13	Fish Landings	49	Residential Construction
14	Hunting & Trapping Products	50	Non-Residential Construction
15	Metallic Ores & Concentrates	51	Repair Construction
16	Mineral Fuels	52	Pipeline Transportation
17	Mon-Metallic Minerals	53	Transportation & Storage
18	Services Incidiental to Mining	54	Radio & Television Broadcasting
19	Meat (excluding poultry)	55	Telephone & Telegraph
20	Margarine & Shortening	56	Postal Service
21	Poultry	57	Electrical Power
22	Dairy Products	58	Other Utilities
23	Fish Products	59	Wholesale Margins
24	Fruits & Vegetable Preparations	60	Retail Margins
25	Feeds	61	Owner Occupied Imputed/Cash Rent
26	Flour/Wheat/Meal/Other Cereals	62	Real Estate & Financial Services
27	Breakfast Cereal & Bakery Pdts.	63	Business Services
28	Misc. Food Products	64	Education Services
29	Vegetable Oils & Fats	65	Health Services
30	Soft Drinks	66	Amusement & Recreation Services
31	Alcoholic Beverages	67	Accommodation & Food Services
32	Tobacco & Tobacco Products	68	Other Personal & Misc. Services
33	Rubber/Leather/Plastic Fab Pdts.	69	Transportation Margins
34	Textile Products	70	Operating/Office/Food/Lab
35	Knitted Products & Clothing	71	Travel/Advertising/Promotion
36	Lumber/Sawmill/Wood Products		

Table 3

LIST OF PRIMARY INPUTS IN THE INPUT-OUTPUT MODEL

No.	Commodity Description	No.	Commodity Description
01	Wages & Salaries	11	Quebec Imports
02	Supplementary Labour Income	12	Ontario Imports
03	Net Inc of Unincorporated Businesses	13	Manitoba Imports
		14	Saskatchewan Imports
04	Investment Income	15	Alberta Imports
05	Exogenous Income	16	British Columbia Imports
06	Other Operating Surplus	17	Imports from Other Canada
07	Indirect Taxes	18	Total Canadian Imports
08	Subsidies	19	Foreign Imports
09	Non-Competitive Imports	20	Total Competitive Imports
10	Atlantic Imports		

Total impacts of the project were estimated by dividing the project into two phases of activities. In the development phase the following items were included:

1. Construction of dams... Rafferty and Alameda.
2. Fencing of the reservoirs.
3. Salvage of gravel from the land to be flooded by the intended reservoirs and clearing of the valley.
4. Development of recreation facilities at the reservoirs plus fish and wildlife enhancement costs.
5. Cottage site development.
6. Dr. Mainprize Park Replacement with a marina added.
7. Modifications to rural (domestic) and urban water supply and sewage treatment.
8. Oil well mitigation for those to be flooded by the reservoirs.
9. Power line relocation
10. Road and related infrastructure relocation.
11. Archaeological survey of the area to be flooded.
12. Lutheran Bible Camp mitigation costs, and
13. Administration costs for SBDA.

Once these costs are incurred, impacts upon the regional and provincial economy would be felt during the operational phase of the project. This phase is to include the following direct expenditures:

1. Irrigation development on farms with production and selling of the products.
2. Recreational facilities visitation.
3. Flood control and power generation expenditures.

4. Operation and maintenance of:

   i) dam & reservoirs
   ii) recreational facilities and cottages
   iii) water supply systems and sewage treatment plant, and
   iv) roads

Irrigation development on farms was assumed to proceed under two alternate scenarios, grain production and livestock production. Details of these scenarios are provided in the Agriculture Appendix. In addition, forward linkage impacts were also estimated for livestock production scenario. The input-output model was used to simulate the impact of each of the above expenditures, and the results added to reflect the total economic impacts of the project.

DIRECT IMPACTS OF THE PROJECT

Following the presentation in the previous section, direct impacts of the project are divided into construction (development) phase and operations phase. Details of expenditures are organized into several categories. For the development phase these categories are:

1. Dam
2. Recreation Facilities
3. Water Supply
4. Other Categories of Expenditures
5. Study Board

During the operations phase, the expenditures are divided into the following categories:

6. Construction of Irrigation Distribution System
7. Investment by Farmers for Irrigation Equipment, and Farm Machinery
8. Irrigation on Farm, including operation and maintenance
9. Operations and Maintenance of:
    i) Dam
    ii) Recreation Facilities
    iii) Water Supply Facilities
    iv) Roads
10. Visitors Expenditures

Each of these expenditure is estimated in appropriate appendices of this report. The figures are summarized in Tables 4 to 6.

Table 4

DEVELOPMENT COST* OF THE RAFFERTY - ALAMEDA RESERVOIRS PROJECT, 1986 DOLLARS

Particulars	Rafferty	Alameda	Total
	- - - -	1,000.	- - - -
Dam			
Construction**	26,350	31,295	$57,645.
Reservoir Clearing	300.	100.	400.
Land Lost:	7,000.	4,410	11,410.
Diversion Channel	9,525.	- -	9,525.
Total:	$43,175.	$35,805.	$78,980.
Recreation Facilities			
Recreation Site	2,690.	1,200.	3,890.
Fish Enhancement	650.	--	650.
Wildlife Enhancement	3,790.	--	3,790.
Dr. Mainprize Park	1,720.	--	1,720.
Subtotal:	$ 8,850.	$ 1,200.	$10,050.
Water Supply	365	60	425
Other Expenditures			
Archaeology	780.	520.	1,300.
Oil Wells Mitigation	18,165.	4,055.	22,220.
Powerline Relocation	300.	600.	900.
Transportation	9,240.	2,885.	12,125.
Subtotal:	$28,485.	$ 8,060.	$36,545.
TOTAL COST:	$80,875.	$45,125.	$126,000.

* Excludes cottage development cost.

** Includes engineering.

- 1985 costs can be derived by dividing above figures by a factor of 1.05

The development phase expenditures (Table 4) are expected to be in the neighbourhood of $126 million. Of this $80.9 million are related to the Rafferty dam and reservoir and $45.1 million for the Alameda project.

Major items of expenses for the Rafferty project are the dam and channel construction ($35.8 million) and oil wells mitigation ($18.2 million). For the Alameda project, the major expense is the construction of the dam.

In addition to the above $126 million, another $23 to $24 million would be spent in bringing the water to the farm gate, and in installing the irrigation equipment and related machinery. (Table 5). Under irrigated conditions, the area would produce $5.32 million per annum extra farm products (over and above under dryland farms), if farmers pursue grain production scenario or $7.54 million per annum extra under livestock production.

However, it would also cost extra to realize this value of production... $3.4 million per annum under grain production scenario and $5.37 million per annum under livestock production scenario.

During the operations phase, public or private institutions will spend $1.3 million annually for the maintenance and upkeep of various components of the project, as shown in Table 6.

Once the project is fully developed, there would be other expenditures... such as recreation related activities (such as park visitation, water sports, golfing, etc.) which would spend $6.9 million annually for the life of the project. There would be savings due to flood control both in Canada and in the U.S. of $2.54

Table 5

DEVELOPMENT AND OPERATIONS COSTS FOR ON-FARM IRRIGATION 1986 DOLLARS

Particulars	Grain Production Scenario	Livestock Production Scenario
	------- $1,000	--------
Construction of Main and Distribution System	$ 9,102.	$ 9,102.
Pivots	8,659.	8,659.
Farm Machinery & Equipment	5,901	5,156.
Subtotal	$23,662.	$22,917.
Gross Farm Revenue	$ 5,319.	$ 7,538.
Cash Expenditures	$ 3,400.	$ 5,368.

Table 6

ANNUAL OPERATION AND MAINTENANCE COSTS FOR RAFFERTY & ALAMEDA PROJECT 1986 DOLLARS

Particulars	Rafferty Dam	Alameda Dam	Total
	----	$1,000	--------
Dam Operations	157	108	265
Fencing	40	10	50
Channel	95	--	95
Recreation Site	404	180	584
Fish Enhancement	21	--	21
Wildlife Enhancement	15	--	15
Dr. Mainprize Park	138	--	138
Water Supply	16	3	19
Transportation	92	29	121
Total	978	330	1,308

million and $60. million respectively over the life of the project. The Saskatchewan Power Corporation would also save $20.3 million (in 1986 dollars over the life of the project) through savings in the cost of power generation.

Each of the above direct impacts would have secondary impacts, which are reported in the next section.

TOTAL IMPACT OF THE PROJECT UPON ECONOMIC ACTIVITY

Secondary impacts of the Rafferty and Alameda reservoirs project are measured in terms of i) household incomes and ii) gross domestic product which includes household incomes, other operating surplus and net indirect taxes. These were then added to the direct impacts. These measures are developed both for the project region... the Souris River Basin, and for the province as a whole. These impacts are presented according to the two phases of the project... development and operations phase.

Total Impacts During the Development Phase

Development phase secondary impacts from backward linkages are shown in Table 7. Impacts upon the project region, in general, are lower than those for the province as a whole. This is because of inter-regional trade that takes place among various regions of the province.

Total provincial impacts of the project during the development phase are estimated at $99.6 million worth of gross domestic product (at market prices) which includes a sum of $60.7 million for household incomes. At the regional level these impacts are slightly lower... at $62.8 million worth of gross domestic product and $40.3 million worth of household incomes. Major impacts are felt through the construction activity and oil well mitigation activity.

Table 7

TOTAL (DIRECT-PLUS SECONDARY) ECONOMIC IMPACTS OF THE RAFFERTY - ALAMEDA RESERVOIRS PROJECT
1986 DOLLARS

Direct Expenditures Activity	Project Region		Province	
	HH*	GDP**	HH*	GDP**
	- - - - - - - - - -	$1,000	- - - - - - - - - -	
Dam				
Construction	19,650	31,629	29,670	49,190
Reservoir Clearing	190	224	272	377
Land Lost, Fencing and Dugout	359	366	491	608
Diversion Channel	3,713	5,274	5,844	8,830
Subtotal	23,912	37,493	36,277	59,005
Recreation Facilities				
Recreation Site	1,089	1,696	1,603	2,660
Cottage Development	2,682	3,777	3,964	6,169
Fish Enhancement	206	328	307	515
Wildlife Enhancement	1,143	1,864	1,692	2,896
Dr. Mainprize Park	449	638	657	1,025
Subtotal:	5,569	8,303	8,223	13,265
Water Supply	63	77	88	127
Other Expenditures				
Powerline Relocation	143	197	206	315
Oil Well Mitigation	6,378	9,862	9,762	16,243
Road Mitigation	4,188	6,851	6,201	10,607
Subtotal:	10,709	16,910	16,169	27,165
TOTAL:	40,253	62,783	60,757	99,562

* HH = Household Income

** GDP = Gross Domestic Product in Market Price.

Total Impacts During the Operations Phase

During the operations phase impacts upon the project region and the province will be felt through farmers' production of various grains and livestock products, through the visitation of local and out-of-region people for recreation activity, and through maintenance and upkeep of the system already in place. These impacts are shown in Table 8. Recreation related activities would contribute $3.0 million annually to the provincial G.D.P. including $1.9 million paid out to the households as incomes. Operation and maintenance expenditures result in a contribution of $1.55 million annually to the provincial G.D.P. of which nearly $1 million is in terms of household income. Agriculture would also contribute to the provincial economy, as well as the power generation. These contributions are measured for the entire life of the project. Agriculture, under the assumption of grain production scenario, contributes $17.9 million to the provincial G.D.P. and $27.3 million if the assumption is changed to livestock production.

Table 8

TOTAL (DIRECT PLUS SECONDARY) IMPACTS DURING THE
OPERATIONS PHASE OF THE RAFFERTY-ALAMEDA RESERVOIRS PROJECT
1986 DOLLARS

Direct Expenditure	Study Region		Province	
Activity	HH**	GDP***	HH**	GDP***
Agriculture - Grain	--	---	-	17,916
- Livestock	--	---	--	27,330
Recreation	1,228	1,833	1,856	3,007
Operation & Maintenance				
Dam	199	308	287	472
Fencing	38	42	53	71
Recreation Site	322	348	451	596
Cottages	57	80	84	131
Fish Enhancement	13	14	18	21
Wildlife Enhancement	11	11	15	18
Dr. Mainprize Park	55	71	79	116
Water Supply	8	14	11	20
Transportation	40	68	60	104
Subtotal:	743	956	1,058	1,552
Power Generation*	-471	-913	-178	-2,325

* HH = Household Income

** GDP = Gross Domestic Product in Market Price.

PROJECT BENEFITS AND COSTS TABLE

		SPECS	PRESENT VALUE COEFFICIENT 5%	GRAIN 5%	LIVESTOCK 5%	PRESENT VALUE COEFFICIENT 10%	GRAIN 10%	LIVESTOCK 10%	ORIGINAL COMMODITY TOTALS
DIRECT BENEFITS									
AGRICULTURE		PV TOT	1.0000	68,139,700	96,573,900	1.0000	32,167,600	45,590,900	0
RECREATION	- Visitor Day	PRJ TOT	8.9924	62,695,013	62,695,013	2.9677	20,690,804	20,690,804	6,972,000
FLOOD CONTROL	- U.S.	PV TOT	1.0000	60,000,000	60,000,000	1.0000	60,000,000	60,000,000	60,000,000
	- CANADA	PV TOT	1.0000	2,541,000	2,341,000	0.5431	1,380,017	1,380,017	2,341,000
POWER GENERATION		PV TOT	1.0000	20,300,000	20,300,000	1.0000	20,300,000	20,300,000	20,300,000
TOTAL DIRECT BENEFITS				213,675,713	242,109,913		134,538,422	147,961,722	
DIRECT COSTS									
AGRICULTURE PRODUCTION COSTS		PV TOT	1.0000	72,550,300	96,781,800	1.0000	40,593,700	51,917,900	0
ALAMEDA -									
DAM	- Dam Construction	PRJ TOT	0.8435	26,397,333	26,397,333	0.7170	22,438,515	22,438,515	31,295,000
	- O & M	ANN	16.6590	1,792,508	1,792,508	8.3487	898,320	898,320	107,600
	- Gravel Salvage	PV TOT	1.0000	0	0	1.0000	0	0	0
	- Reservoir Clearing	PRJ TOT	0.9520	95,200	95,200	0.6830	68,300	68,300	100,000
	- Land Cost	PRJ TOT	1.0000	4,310,000	4,310,000	1.0000	4,310,000	4,310,000	4,310,000
	- Fencing & Dugout	PRJ TOT	0.8640	86,400	86,400	0.6830	68,300	68,300	100,000
	- O & M	ANN	15.5330	155,330	155,330	7.4280	74,280	74,280	10,000
RECREATION	- Recreation Site	PRJ TOT	0.6354	762,480	762,480	0.3930	471,600	471,600	1,200,000
	- O & M	ANN	13.9270	2,506,860	2,506,860	6.1240	1,102,320	1,102,320	180,000
	- Cottage Site Development	PRJ TOT	0.7650	535,500	535,500	0.5925	414,750	414,750	700,000
	- Construction	PRJ TOT	0.6354	1,906,200	1,906,200	0.4197	1,259,100	1,259,100	3,000,000
	- O & M	ANN	11.7930	1,309,023	1,309,023	4.9470	549,117	549,117	111,000
WATER	- Rural Water	PRJ TOT	0.8445	50,670	50,670	0.7203	43,218	43,218	60,000
	- O & M	ANN	13.9270	41,781	41,781	6.1240	18,372	18,372	3,000
OTHER	- Heritage Resources	PV TOT	0.9157	476,164	476,164	0.8465	440,180	440,180	520,000
	- Oil Well Mitigation	PRJ TOT	0.6156	2,496,258	2,496,258	0.6718	2,724,149	2,724,149	4,055,000
	- Power Line Relocation	PRJ TOT	0.9295	557,700	557,700	0.7170	430,200	430,200	600,000
	- Transportation	PRJ TOT	0.9295	2,681,608	2,681,608	0.7170	2,068,545	2,068,545	2,885,000
	- O & M	ANN	16.6590	483,111	483,111	8.1790	237,191	237,191	29,000
SUBTOTAL - ALAMEDA				46,644,125	46,644,125		37,616,457	37,616,457	

PROJECT BENEFITS AND COSTS TABLE

		SPECS	PRESENT VALUE COEFFICIENT 5%	GRAIN 5%	LIVESTOCK 5%	PRESENT VALUE COEFFICIENT 10%	GRAIN 10%	LIVESTOCK 10%	ORIGINAL COMMODITY TOTALS
RAFFERTY -									
DAM	- Dam Construction	PRJ TOT	0.9252	24,379,020	24,379,020	0.7170	18,892,950	18,892,950	26,350,000
	- O & M	ANN	17.9673	2,813,679	2,813,679	9.4759	1,483,926	1,483,926	156,600
	- Gravel Salvage	PV TOT	1.0000	0	0	1.0973	0	0	0
	- Reservoir Clearing	PRJ TOT	0.9520	285,600	285,600	0.6830	204,900	204,900	300,000
	- Land Cost	PRJ TOT	1.0000	6,600,000	6,600,000	1.0000	6,600,000	6,600,000	6,600,000
	- Fencing & Dugout	PRJ TOT	0.8640	345,600	345,600	0.6830	273,200	273,200	400,000
	- O & M	ANN	15.5330	621,320	621,320	7.4280	297,120	297,120	40,000
DIVERSION CHANNEL	- Channel Construction	PRJ TOT	0.9430	8,982,075	8,982,075	0.8920	8,496,300	8,496,300	9,525,000
	- O & M	ANN	17.9676	1,711,414	1,711,414	9.4759	902,579	902,579	95,250
RECREATION	- Recreation Site : Lower	PRJ TOT	0.6354	1,709,226	1,709,226	0.3930	1,057,170	1,057,170	2,690,000
	- O & M	ANN	13.9270	5,619,545	5,619,545	6.1240	2,471,034	2,471,034	403,500
	- Cottage Site Development	PRJ TOT	0.7650	937,125	937,125	0.5925	725,813	725,813	1,225,000
	- Construction	PRJ TOT	0.6354	3,335,850	3,335,850	0.4197	2,203,425	2,203,425	5,250,000
	- O & M	ANN	11.7930	2,287,842	2,287,842	4.9470	959,718	959,718	194,000
	- Fish Enhancement	PRJ TOT	0.7840	509,600	509,600	0.6210	403,650	403,650	650,000
	- O & M	ANN	13.9270	292,467	292,467	6.1240	128,604	128,604	21,000
	- Wildlife Enhancement	PRJ TOT	1.0700	3,536,350	3,536,350	1.0000	3,305,000	3,305,000	3,305,000
	- O & M	ANN	17.3040	259,560	259,560	9.0060	135,090	135,090	15,000
	- Dr. Mainprize Park	PRJ TOT	0.9295	1,598,740	1,598,740	0.8675	1,492,100	1,492,100	1,720,000
	- O & M	ANN	16.3970	2,262,786	2,262,786	8.1790	1,128,702	1,128,702	138,000
WATER	- Rural Water	PRJ TOT	0.8445	266,018	266,018	0.7203	226,895	226,895	315,000
	- O & M	ANN	13.9270	219,350	219,350	6.1240	96,453	96,453	15,750
	- Urban Water-Hitchcock	PRJ TOT	0.9520	47,600	47,600	0.9090	45,450	45,450	50,000
	- O & M	ANN	17.3040	0	0	9.0060	0	0	0
	- Weyburn Sewage	PRJ TOT	0.9520	0	0	0.9090	0	0	0
	- O & M	ANN	17.3040	0	0	9.0060	0	0	0
OTHER	- Bible Camp Mitigation	PRJ TOT	0.9520	0	0	0.9090	0	0	0
	- Heritage Resources	PV TOT	0.9157	714,246	714,246	0.8465	660,270	660,270	780,000
	- Oil Well Mitigation	PRJ TOT	0.6156	11,182,374	11,182,374	0.6718	12,203,247	12,203,247	18,165,000
	- Power Line Relocation	PRJ TOT	0.9295	278,850	278,850	0.8675	260,250	260,250	300,000
	- Transportation	PRJ TOT	0.9295	8,588,580	8,588,580	0.8675	8,015,700	8,015,700	9,240,000
	- O & M	ANN	17.9673	1,652,992	1,652,992	8.1790	752,468	752,468	92,000
	-Telephone Line Relocation	PRJ TOT	0.9295	0	0	0.8675	0	0	0
SUBTOTAL - RAFFERTY				91,037,808	91,037,808		73,422,013	73,422,013	
ADMINISTRATION	- Souris Basin Authority	PRJ TOT	0.9295	3,718,000	3,718,000	0.8675	3,470,000	3,470,000	4,000,000
TOTAL COSTS				213,950,233	238,181,733		155,102,171	166,426,371	

PROJECT BENEFITS AND COSTS TABLE

		SPECS	PRESENT VALUE COEFFICIENT 5%	GRAIN 5%	LIVESTOCK 5%	PRESENT VALUE COEFFICIENT 10%	GRAIN 10%	LIVESTOCK 10%	ORIGINAL COMMODITY TOTALS
NET INDIRECT BENEFITS									
AGRICULTURE		PV TOT	1.0000	26,197,052	41,438,521	1.0000	14,779,625	21,874,068	0
RECREATION	- Visitor Day	PRJ TOT	8.9924	48,397,097	48,397,097	2.9677	15,972,161	15,972,161	5,382,000
ALAMEDA -									
DAM	- Dam Construction	PRJ TOT	0.8435	12,189,419	12,189,419	0.7170	10,361,367	10,361,367	14,451,000
	- O & M	ANN	16.6590	1,206,828	1,206,828	8.3487	604,805	604,805	72,443
	- Fencing & Dugout	PRJ TOT	0.8640	32,832	32,832	0.6830	25,954	25,954	38,000
	- O & M	ANN	15.5330	62,132	62,132	7.4280	29,712	29,712	4,000
	- Reservoir Clearing	PRJ TOT	0.9520	62,832	62,832	0.6830	45,078	45,078	66,000
RECREATION	- Recreational Site	PRJ TOT	0.6354	409,833	409,833	0.3930	253,485	253,485	645,000
	- O & M	ANN	13.9270	1,490,189	1,490,189	6.1240	655,268	655,268	107,000
	- Cottage Site Development	PRJ TOT	0.7650	207,315	207,315	0.5925	160,568	160,568	271,000
	- Construction	PRJ TOT	0.6354	739,129	739,129	0.4197	488,216	488,216	1,163,250
	- O & M	ANN	11.7930	501,203	501,203	4.9470	210,248	210,248	42,500
WATER	- Rural Water	PRJ TOT	0.8445	8,234	8,234	0.7203	7,023	7,023	9,750
	- O & M	ANN	13.9270	37,603	37,603	6.1240	16,535	16,535	2,700
OTHER	- Oil Well Mitigation	PRJ TOT	0.6156	1,437,426	1,437,426	0.6718	1,568,653	1,568,653	2,335,000
	- Power Line Relocation	PRJ TOT	0.9295	120,835	120,835	0.7170	93,210	93,210	130,000
	- Road Mitigation	PRJ TOT	0.9295	1,860,859	1,860,859	0.7170	1,435,434	1,435,434	2,002,000
	- O & M	ANN	16.6590	333,180	333,180	8.1790	163,580	163,580	20,000
LAND LOST	- Agriculture	PRJ TOT	18.2560	(273,840)	(273,840)	9.9150	(148,725)	(148,725)	(15,000)
SUBTOTAL - ALAMEDA				20,426,008	20,426,008		15,970,410	15,970,410	

PROJECT BENEFITS AND COSTS TABLE

		SPECS	PRESENT VALUE COEFFICIENT 5%	GRAIN 5%	LIVESTOCK 5%	PRESENT VALUE COEFFICIENT 10%	GRAIN 10%	LIVESTOCK 10%	ORIGINAL COMMODITY TOTALS
RAFFERTY -									
DAM	- Dam Construction	PRJ TOT	0.9252	17,127,302	17,127,302	0.7170	13,273,104	13,273,104	18,512,000
	- O & M	ANN	17.9673	5,192,550	5,192,550	9.4759	2,738,535	2,738,535	289,000
	- Fencing & Dugout	PRJ TOT	0.8640	326,592	326,592	0.6830	258,174	258,174	378,000
	- O & M	ANN	15.5330	621,320	621,320	7.4280	297,120	297,120	40,000
	- Reservoir Clearing	PRJ TOT	0.9520	188,496	188,496	0.6830	135,234	135,234	198,000
DIVERSION CHANNEL	- Channel Construction	PRJ TOT	0.9430	5,608,964	5,608,964	0.8920	5,305,616	5,305,616	5,948,000
	- O & M	ANN	17.9676	1,068,713	1,068,713	9.4759	563,627	563,627	59,400
RECREATION	- Recreation Site	PRJ TOT	0.6354	918,153	918,153	0.3930	567,885	567,885	1,445,000
	- O & M	ANN	13.9270	3,342,480	3,342,480	6.1240	1,469,760	1,469,760	240,000
	- Cottage Site Development	PRJ TOT	0.7650	363,375	363,375	0.5925	281,438	281,438	475,000
	- Construction	PRJ TOT	0.6354	1,342,283	1,342,283	0.4197	886,616	886,616	2,112,500
	- O & M	ANN	11.7930	878,579	878,579	4.9470	368,552	368,552	74,500
	- Fish Enhancement	PRJ TOT	0.7840	348,880	348,880	0.6210	276,345	276,345	445,000
	- O & M	ANN	13.9270	167,124	167,124	6.1240	73,488	73,488	12,000
	- Wildlife Enhancement	PRJ TOT	0.9520	2,196,264	2,196,264	0.9090	2,097,063	2,097,063	2,307,000
	- O & M	ANN	17.3040	129,780	129,780	9.0060	67,545	67,545	7,500
	- Dr.Mainprize Park	PRJ TOT	0.9295	367,153	367,153	0.8675	342,663	342,663	395,000
	- O & M	ANN	16.3970	1,246,172	1,246,172	8.1790	621,604	621,604	76,000
WATER	- Rural Water	PRJ TOT	0.8445	43,211	43,211	0.7203	36,856	36,856	51,167
	- O & M	ANN	13.9270	160,342	160,342	6.1240	70,506	70,506	11,513
	- Urban Water-Hitchcock	PRJ TOT	0.9520	23,800	23,800	0.9090	22,725	22,725	25,000
	- O & M	ANN	17.3040	0	0	9.0060	0	0	0
	- Weyburn Sewage	PRJ TOT	0.9520	0	0	0.9090	0	0	0
	- O & M	ANN	17.3040	0	0	9.0060	0	0	0
OTHER	- Oil Well Mitigation	PRJ TOT	0.6156	6,698,344	6,698,344	0.6718	7,309,856	7,309,856	10,881,000
	- Power Line Relocation	PRJ TOT	0.9295	59,488	59,488	0.8675	55,520	55,520	64,000
	- Road Mitigation	PRJ TOT	0.9295	6,022,231	6,022,231	0.8675	5,620,533	5,620,533	6,479,000
	- O & M	ANN	17.9673	1,149,907	1,149,907	8.1790	523,456	523,456	64,000
	-Telephone Line Relocation	PRJ TOT	0.9295	0	0	0.8675	0	0	0
LAND LOST	- Agriculture	PRJ TOT	18.2560	(638,960)	(638,960)	9.9150	(347,025)	(347,025)	(35,000)
POWER GENERATION UNITS		PV TOT	1.0000	(575,000)	(575,000)	1.0000	(575,000)	(575,000)	(575,000)
SUBTOTAL - RAFFERTY				54,377,540	54,377,540		42,341,793	42,341,793	
ADMINISTRATION	- Souris Basin Authority	PRJ TOT	0.9295	4,561,986	4,561,986	0.8675	4,257,690	4,257,690	4,908,000
TOTAL INDIRECT BENEFITS				153,959,682	169,201,151		93,321,679	100,416,122	

BENEFIT/COST ANALYSIS

APPENDIX

SOURIS BASIN DEVELOPMENT AUTHORITY

1987

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INTRODUCTION

Desirability of a project from either a private or a public viewpoint is judged by the criterion of benefits and costs, for the appropriate accounting stance. This criterion is applied in the context of the Souris River Development through the construction and operation of the Rafferty and Alameda reservoirs. This criterion is applied in two alternate forms:

i) Net Present Value of Benefits
ii) Benefit-Cost Ratio

A net present value of benefits (NPB) which is larger than 0, yields a benefit/cost ratio (BCR) of one or greater. Thus, the two criterion are internally consistent with each other. A positive NPB or a larger than one BCR suggests that the project is desirable from the point of view of the accounting stance group. A negative NPB or a less than one BCR suggests otherwise.

Net Present Value and Discount Rates

Projects incur costs and provide benefits over a period of time. Typically, costs such as construction costs are incurred at the start of a project and may taper off over time to the level of maintenance costs. Benefits may not begin to accrue until construction is complete and may continue to be enjoyed for many years.

In a world where households, firms, and governments are prepared to pay a premium to have money today, as opposed to some point in the future, it is reasonable to weight (discount) future benefits and costs somewhat less than those values would be weighted today. In benefit-cost analysis, this premium or interest rate is known as the discount rate. To weight future values in terms of today's values is to obtain the present value (PV) where:

$$PV_i = \frac{1}{(1+r)^i} \cdot V_i$$

Where V = the benefit or cost experienced in period i,
i = time period = 0, 1, 2, ... n, and
r = the discount rate expressed as a decimal.

Thus, the further in the future the benefit or cost is experienced, the greater its contribution to PVA is discounted. The choice of the rate is crucial to the economic feasibility of the project. Generally, for water resource projects, the higher the discount rate, the less attractive the project. This is due to the fact that the benefits accrue further off in the future than the costs and are discounted more heavily.

STUDY METHODOLOGY

The estimation of benefits and costs in this report is done from the standpoint of the Saskatchewan economy. Any benefits to the people of the province are adjusted against any costs to them. These benefits and costs are estimated on an incremental basis... over and above what they would be without the project.

Four sources of benefits are identified:

i) Agricultural production.
ii) Recreation and Tourism.
iii) Flood control benefits to U.S. and to Saskatchewan.
iv) Power generation cost savings.

These four sources of benefits are compared against the following costs:

i) Agricultural operating expenses and investment costs.
ii) Dam construction.
iii) Development of recreation facilities.
iv) Changes in related infrastructure such as power lines, roads, etc.
v) Water supply systems.
vi) Other expenditures such as archaeology, study board, etc.

Three alternative evaluations are made for the project:

i) Direct Benefits and Costs.
ii) Direct Benefits and Costs plus Forward Linkages Impacts for livestock processing.
iii) Social Benefits and Costs, which include both Backward and Forward Linkages Impacts.

Evaluations (i) and (iii) above are made for both grain production and livestock production scenarios, whereas the evaluation (ii) was carried out only for the livestock production scenario.

The rates of discount selected for these analyses are 5% and 10%. Thus, a direct benefit-cost ratio can be calculated as:

$$\text{Direct Net Present Value of Benefits (DNPB)} = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

where,

n = life of the project
t = time period (1, ..., n)
B_t = current value of benefits
C_t = current value of costs

$$\text{Direct BCR} = 1 + \frac{\text{DNPB}}{\sum_{t=1}^{n} \{C_t/(1+r)^t\}}$$

where, BCR is the benefit-cost ratio for the project.

The second evaluation is arrived at as follows:

$$\text{Direct Plus Forward Linkage NPB [DFNPB]} = \text{DNPB} + \sum_{t=1}^{n} \frac{(FB_t - FC_t)}{(1 + r)^t}$$

where, FB_t and FC_t are respectively, forward linked benefits and costs.

Thus,

$$\text{Direct-Forward BCR} = 1 + \frac{\text{DF NPB}}{\sum_{t=1}^{n} \{C^t/(1+r)^t\}}$$

The third evaluation... Social Benefit-costs is done as follows:

$$\text{Social NPB} = \text{DFNPB} + \sum_{t=1}^{n} \frac{(SB_t - SC_t)}{(1+r)^t}$$

Where, SB_t and SC_t, are respectively, secondary benefits and costs.

The social benefit-cost ratio (SBCR) can be done using the social NPB (SNPB) as follows:

$$\text{SBCR} = 1 + \frac{\text{SNPB}}{\sum_{t=1}^{n} \{C_t/(1+r)^t\}}$$

Thus, one would expect the social benefit-cost ratio to be largest, as it includes both direct plus direct forward net benefits as well as the secondary backward linked net benefits. Secondary and forward linked benefits were estimated as change in provincial GDP net of capital cost allowance. In the estimation of the present value a time path of expenditures and revenues was assumed; these are shown in the Annex. In the next section the results of the three evaluations are presented.

RESULTS

Direct Net Benefits and Benefit-Cost Ratio

Benefits and costs of the project to the province of Saskatchewan are estimated using a five percent and a ten percent discount rate. These are shown in Table .1. At the five percent discount rate, the benefits are estimated to be $213.7 million if farmers were to pursue more grain production (and relatively less livestock production) activities. These benefits are slightly enhanced to $242 million if more livestock production activities are pursued. The benefits to the U.S.A. for flood control and the savings to the Saskatchewan Power customers are in the form of contributions in Canadian funds. These contributions are assumed to remain unchanged under the two discount rates at $60.0 million and $20.3 million, respectively. At the 10% discount rate, the benefits are estimated at $134.5 and $147.96 million, respectively, for the grain and livestock production scenarios.

The direct costs of the project are estimated at $213.9 and $238.2 million respectively, for the grain and livestock production scenarios, both evaluated at 5% rate of discount. These present value of costs decline to $155.1 and $166.4 million respectively, for grain and livestock production scenarios at the 10% discount rate.

The net present value of benefits is negative for 3 of the 4 scenarios in Table 1, suggesting that the benefits do not totally cover the costs, and therefore, if the project were to be judged only on this basis it is not economical. However, the livestock production scenario, at a 5% discount rate is positive and benefits do cover costs. The benefit-cost ratio of 0.87 is the lowest at a 10% discount rate, if farmers do not divert a part of their production towards cattle; otherwise the ratio is increased to 0.89. At the 5% rate of discount, the project has a slightly higher ratio at 1.00 to 1.016... depending upon the assumption of production scenario.

Table 1

DIRECT BENEFITS AND COSTS OF THE SOURIS RIVER DEVELOPMENT PROJECT 1986 DOLLARS

Particulars		r = .05	r = .10
Benefits		Net Present Value in $1,000.	
Agriculture			
- grain production		68,140.	32,168.
- livestock scenario		96,574.	45,591.
Recreation & Tourism		62,695.	20,691.
Flood Control - USA		60,000.	60,000.
- Canada		2,541.	1,380.
Power Generation		20,300.	20,300.
Total Benefits	- Grain	213,676.	134,539.
	- Livestock	242,110.	147,962.
Costs			
Agriculture:			
- grain production		72,550.	40,594.
- livestock production		96,782.	51,918.
Dam Construction		56,539	44,355.
Diversion Channel Construction		10,693.	9,399.
Recreation Facilities		29,372.	17,807.
Water Supply		625.	430.
Land, Fencing and Dugout		12,118.	11,622.
Other Items		28,335.	27,424.
Administration		3,718.	3,170.
Total Costs	- Grain	213,950.	155,102.
	- Livestock	238,182.	166,426
Total Net Present Benefits	- Grain	- 274.	-20,563.
	- Livestock	+ 3,928.	-18,464.
Benefit Cost Ratio	- Grain	0.999	0.867
	- Livestock	1.016	0.889

DIRECT AND FORWARD LINKAGE NET PRESENT BENEFITS

If area farmers adopt a livestock production operation, more cattle would be produced which could then be processed locally within Saskatchewan. The net profit resulting from this increased production should be counted as a benefit to the Saskatchewan society. In addition, forward linkage benefits stemming from the meat processing industry must also be included. Table 2 outlines the project benefit-cost ratio with these forward benefits added to the total project benefits. This slightly improves the desirability of the project as the benefit-cost ratio increases to 1.031 from 1.016 at a 5% discount rate, and to 0.900 from 0.889 at a 10% discount rate.

Table 2

DIRECT AND FORWARD LINKAGE BENEFITS AND COSTS OF THE SOURIS DEVELOPMENT PROJECT, 1986 DOLLARS

Particulars	r = .05	r = .10
	..............$1,000..	....
Livestock Production Direct Total Benefits	242,110.	147,962.
Forward Linkage Net Benefits	3,371.	1,860.
Total Direct and Forward Linkage Benefits	245,481.	149,822.
Total Costs	238,182.	166,426.
Direct and Forward Linkage Benefit-Cost Ratio	1.031	0.900.

Shown in Table 3 is the direct plus forward net present benefits, equal to the total net present benefits plus forward linkage net benefits. Net present benefits are preferred by some analysts as an alternate economic indicator of project viability. This indicator includes a measure of the magnitude of the project's economic impact and is estimated by subtracting all discounted costs associated with the project from discounted project benefits.

If the forward linkage impacts are included, the net present benefits for the livestock scenario increase to $7.2 million at 5% and $16.6 million at 10%.

Table 3

DIRECT PLUS FORWARD LINKAGE
NET PRESENT BENEFITS, 1986 DOLLARS

Particulars	r = .05	r = .10
	............$1,000	....
Livestock Production Direct Net Present Value of Benefits	3,928.	18,464.
Forward Linkage Net Benefits	3,371.	1,860.
Direct Plus Forward Net Present Benefits	7,229.	-16,604.

SOCIAL NET PRESENT VALUE OF BENEFITS AND BENEFIT-COST RATIO

When secondary benefits are included the desirability of the project improves significantly, as shown in Tables 4 to 6. Table 4 outlines the net present value of direct plus secondary benefits and the benefit-cost ratio for the project not including forward linkage impacts. The net present value of the benefits is estimated to be $153.7 and $173.2 million respectively for grain and livestock production scenarios, using a 5% discount rate. This yields a benefit-cost ratio of 1.72 for grain and 1.73 for the livestock production scenario. Under a 10% discount rate the benefit-cost ratio ranges between 1.47 and 1.49 for the two production scenarios.

Table 4

SOCIAL BENEFITS AND COSTS OF THE SOURIS RIVER DEVELOPMENT PROJECT, 1986 DOLLARS

		(Direct Plus Secondary)	
Particulars		r = .05	r = .10
		...........$1,000...........	
Direct Net Benefits			
- Grain Production		- 274.	-20,563.
- Livestock Production		+ 3,998.	-18,464.
Secondary (Backward Linkages) Net Benefits			
Agriculture	- Grain	26,197.	14,780.
	- Livestock	41,439	21,874.
Recreation & Tourism		48,397.	15,972.
- Dam Construction		37,007.	27,723.
- Diversion Channel		6,678.	5,868.
- Water Supply		273.	154.
- Recreation Facilities		14,644.	8,816.
- Other		17,680.	16,769.
- Land Lost		- 913.	-496.
- Power Generation		- 575.	- 575.
- Administration		4,562.	4,258.
Subtotal:	- Grain	153,950.	93,269.
	- Livestock	169,192.	100,363.
Net Present Benefits	- Grain	153,676.	72,706.
	- Livestock	173,190.	81,899.
Benefit-Cost Ratio	- Grain	1.718	1.469
	- Livestock	1.727	1.492

If forward linkage impacts are included the net present benefits increase to $176.5 million at 5% and $83.8 million at 10% discount rate, yielding a benefit cost ratio 1.741 and 1.503 respectively. Table 5 shows the calculation of net present benefits and a benefit-cost ratio including these forward linkage benefits resulting from increased production in the meat processing industry.

Table 5

SOCIAL AND FORWARD LINKAGE BENEFITS AND COSTS OF THE SOURIS DEVELOPMENT PROJECT, 1986 DOLLARS

Particulars	r = .05	r = .10
	.... $1,000	....
Livestock Production Direct Total Benefits	242,110	147,962
Livestock Production Secondary Total Benefits	169,192	100,363
Forward Linkage Net Benefits	3,371	1,860
Total Direct, and Secondary Benefits	414,673	250,185
Total Costs	238,182	166,426
Net Social Benefits	176,491	83,759
Secondary and Forward Linkage Benefit - Cost Ratio	1.741	1.503

ANNEX

TIME HORIZONS

Time measured from 1st year of Rafferty construction:

Weighted by proportion of expenditure.

Overall length of project is 50 years from initial construction.

Activity	Year	% of Total Budget
Mainprize		
Start relocation	year 1	50
	2	50
Bible Camp		
Start relocation	1	100
Fish Rearing Ponds		
Construction	5	100
Recreation & User Days	5	10)
	-	)10% per year to
	-	)year 14 inclusive
	-	)full utilization
	--	)in year 15
	10	10)
	-	)
	-	)
	-	)
	-	)
	15	10)

Activity	Year	% of Total Budget
Recreation & Marina Sites		
(Rafferty & Alameda)	2	10
	3	0
	4	0
	5	20
	6	20
	7	20
	8	20
	9	10
Cottage Capital Costs		
Servicing	5	50
	6	50
Cottage Construction	5	)Same as user
	-	)days @ 10% per
	-	)year to year
	-	)14 inclusive
	15	
Municipal Intake	1	100
Rural Water Mitigation	2	25
	3	25
	4	25
	5	25
Rafferty Dam Construction	1	50
	2	50
Diversion Channel Construction	1	80
		20

Activity	Year	% of Total Budget
Alameda Dam Construction	3	50
	4	50
Valley Clearing	1	100
Fence	3	100
Archaeological	0	24
	1	28
	2	16
	3	11
	4	11
	5	10
Oil Well	3	20
	4	40
	5	40
Transportation	1	50
	2	50
Power Lines	1	100
Phone Lines	1	100

Activity	Year	% of Total Budget
Recreation & Marina Sites		
(Rafferty & Alameda)	2	10
	3	0
	4	0
	5	20
	6	20
	7	20
	8	20
	9	10
Cottage Capital Costs		
Servicing	5	50
	6	50
Cottage Construction	5	)Same as user
	-	)days @ 10% per
	-	)year to year
	-	)14 inclusive
	15	
Municipal Intake	1	100
Rural Water Mitigation	2	25
	3	25
	4	25
	5	25
Rafferty Dam Construction	1	50
	2	50
Diversion Channel Construction	1	80
		20

Activity	Year	% of Total Budget
Alameda Dam Construction	3	50
	4	50
Valley Clearing	1	100
Fence	3	100
Archaeological	0	24
	1	28
	2	16
	3	11
	4	11
	5	10
Oil Well	3	20
	4	40
	5	40
Transportation	1	50
	2	50
Power Lines	1	100
Phone Lines	1	100